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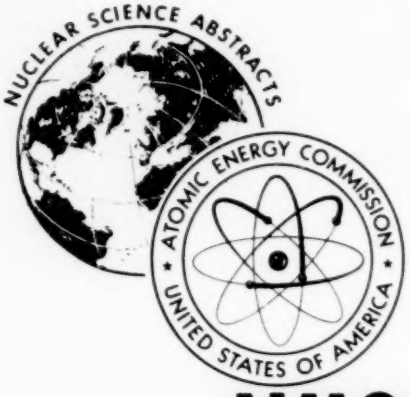

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Volume 17, Number 22, November 30, 1963

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Volume 17, Number 22 November 30, 1963

NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

37001 (ANL-6780) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, AUGUST 1963. (Argonne National Lab., Ill.). Sept. 15, 1963. Contract W-31-109-eng-38. 63p.

Boiling Water Reactors. Zero-power experiments were carried out on the central superheater core CSH-1 of BORAX V. The chemistry of the reactor cooling water was followed. The maintenance and development involved in BORAX V are described. Liquid-Metal-Cooled Reactors. Central reactivity coefficient and Doppler coefficient measurements are reported for a 4000-liter core in Assembly 43 of ZPR-III. Development of fast reactor fuels is described. The operation of EBR-I, Mark IV and EBR-II is described. The fuel cycle facility and process development of EBR-II are also considered. The design studies and other development work on FARET are discussed. General Reactor Technology. Nuclear physics studies which were made included Doppler effect calculations, numerical integration of differential equations, and development of a solid-state fast neutron spectrometer. Corrosion studies on reactor materials are described. The development of ceramic and particulate metal fuel elements is discussed, and the irradiation and extrusion studies are described. Among the chemical studies carried out were the formation of Tc_2Zn_{11} in Tc–Zn, dissolution of U in flowing liquid Cd, thermal decomposition of UO_2Cl_2 in molten LiCl–KCl, solubility of U in Cd–Mg–Zn alloys, fluidization and volatility separation processes, preparation of UC and US, analysis of PuF_6, solubility of Ar in Na, etc. In the Plutonium Recycle Program, the cross-section correction factors for the Pu region and the building of Sm^{149} in the reactor zones are discussed. Advanced Systems Research and Development. The operation of a thermionic film-boiling liquid-metal diode with cesium is described. The design of a nuclear magnetohydrodynamic system (fast reactor coupled with liquid-sodium MHD generator) was analyzed, and the system characteristics are tabulated. Nuclear Safety. Oxidation studies were carried out on Pu and Pu–2 at.% Al alloy. The Al–U_3O_8 thermite reaction and the vapor-phase burning of Al in water were studied. In-pile oxidation studies in air were made on one sample of U and one sample of a U–Fs alloy. (D.L.C.)

37002 (HMI-B-26) JAHRESBERICHT 1962. (Annual Report, 1962). (Hahn-Meitner-Institut für Kernforschung, Berlin). June 1963. 115p.

Progress on nuclear chemistry, mathematics, and nuclear physics is reported. Topics covered include: noble gas diffusion in solids, precipitation and fixiation of radionuclides, behavior of gaseous fission products in the BER, reactor operation, radiation protection and environmental control, radioactive waste, radionuclide production, mathematics, and accelerators. (M.C.G.)

37003 (HW-78118) RESEARCH AND DEVELOPMENT PROGRAMS EXECUTED FOR THE DIVISION OF REACTOR DEVELOPMENT. Quarterly Progress Report, January–March 1963. M. M. Hendrickson and J. K. Green, eds. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1963. Contract AT(45-1)-1350. 157p.

A study was made of the possible production of Cm^{242} and Cm^{244} and several other decay heat source isotopes in current reactor types. The study shows that if credit is taken for Cm and Am, fuel cycle costs are reduced by 0.2 to 0.6 mills/kwh. Plutonium values for many reactor types were computed and compared with the costs of U^{235} burnup. Studies were carried out on the remote processing of PRTR fuel assemblies using a salt bath. Two spray calcination runs and three pot calcination runs were made. Thermodynamic equilibrium constants were determined in the binary systems K–Cs, K–Na, and Na–Cs for seven zeolites. Two micropilot plant runs were made to evaluate the decontamination ability of thin precoat beds of cation exchange resins. Studies were made on the various properties of plutonium and uranium ceramic materials. The fabrication, testing, and irradiation program of thorium fuel elements are described. Studies were made on the fabrication of ceramic and cermet fuels by pneumatic impaction. Various studies were made on the properties and testing of fuels. Graphite was irradiated at ~625°C for exposures of up to 6500 Mwd/at. under stresses of 150 and 300 psi. The contractions were greater for the stressed samples than for the unstressed samples, but were similar for both stress levels. Space-energy distributions of neutrons were calculated for the water loop in ETR. Intercalibration ratios of the first and second sample distributions in the counting intercalibration program are presented for eight reactor sites. The development of nondestructive testing methods is described. Studies are being carried out on the radiation effects on Zircaloy-2, stainless steel, nickel-base alloys, and graphite. Corrosion and oxidation studies were made on Zr alloys, Ni alloys, and stainless steel. Heat transfer experiments on an electrically heated 19-rod bundle model were conducted to determine the effect of rod spacers on boiling burnout. Calculations were made on the thermal flux and multiplication factor of plutonium-fueled lattices. A series of PCTR experiments on plutonium-fueled lattices were analyzed, and two-zone subcritical

experiments on Pu–Al fuel rods in light water are described. The operation and activities of the PRTR and its critical facility are described. (D.L.C.)

37004 (IITRI-1194-13) LITERATURE SURVEY ON WORLD ISOTOPE AND RADIATION TECHNOLOGY. Final Report, June 15, 1961 to June 14, 1962. J. W. Haffner (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Contract AT(11-1)-578. 66p.

In order to study the uses and technology of radioisotopes in the countries of the world, with particular reference to the USA and USSR, a survey of the open literature appearing since 1955 was made. Papers or abstracts of papers were classified by country, year of publication, and subject matter. The subject material was divided into the following eight categories: industrial applications of radioisotopes; metallurgy research; geology, mining, and meteorology; radiochemistry research; physics research; radioisotope apparatus and techniques; food, botany, and agriculture; zoology and medicine. The survey was planned to include two phases. Phase I involved the direct comparison of radioisotope work in all fields in various countries as demonstrated at international conferences. Phase II was devoted to a more detailed study of work in the above fields using such literature sources as Nuclear Science Abstracts. In Phase II, the work of most countries in each category was analyzed by chronological growth rate, subcategory region of interest, and quality of the research being published. The main results of Phase II are presented in graphical and tabular form. The results and conclusions presented were based upon the literature examined in the course of this investigation. (auth)

37005 (KR-49) QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1963. (Norway. Institutt for Atomenergi, Kjeller). 53p.

Operation and development of reactors and nuclear equipment in Norway are discussed. Eight fuel elements were changed in JEEP and a third safety rod was installed. The prototype control station designed for JEEP II is described. Buckling and thermal utilization measurements of four different cores in NORA were compared with the results obtained by three different computer methods for the buckling and four methods for the thermal utilization. A small, high efficiency neutron detector based on a semiconductor was investigated for use in the future compact cores of NORA. A simple magnetic tape recorder is evaluated for 12 channels. Both the intensity and the resolution of the neutron diffractometer were improved by changing from a lead crystal to a copper crystal. The magnetic moments of chromium tellurides were studied by neutron diffraction methods. The sintering of 1300 kg of uranium dioxide powder was finished. The corrosion studies on mild steel and aluminum-nickel-silicon systems were continued. Two fuel elements for JEEP and two dummy fuel elements for JEEP II were completed. In the reprocessing pilot plant seven slugs of uranium with 30 days cooling were processed. Work on ruthenium chemistry was continued. Preliminary studies of the use of molecular sieves in uranium reprocessing were started. The number of isotope deliveries was increased. The studies of radio-colloidals of yttrium and gold for medical purposes were continued. An investigation was started on the blood labelling efficiency of chromium-51. (N.W.R.)

37006 (NP-13095) FIFTH REPORT ON THE ACTIVITIES OF THE AGENCY. (European Nuclear Energy Agency, Paris). July 1963. 154p.

The development and research activities of the European Nuclear Energy Agency are discussed. Topics covered include: development and construction of Eurochemic radiochemical processing plant; development and operation of Halden, Dragon, and Very-High-Flux Reactors; nuclear ship propulsion considerations; reactor physics; nuclear data; electronic computation; direct energy conversion; regulation and control of public health; environmental radioactivity; transportation of radioactive materials; third party liability; security control; radioisotope production and uses; listings of reactors and critical assemblies; and development and economic aspects of nuclear power plants. (N.W.R.)

37007 (NYO-9505) RADIUM AND MESOTHORIUM POISONING AND DOSIMETRY AND INSTRUMENTATION TECHNIQUES IN APPLIED RADIOACTIVITY. Annual Progress Report. (Massachusetts Inst. of Tech., Cambridge. Radioactivity Center). May 1963. Contract AT(30-1)-952. 165p.

Separate abstracts were prepared for 7 sections of this report. A list is included of publications during the period covered by this report. (C.H.)

37008 (NYO-9505(p.1-39)) RADIUM AND MESOTHORIUM TOXICITY IN HUMAN BEINGS. (Massachusetts Inst. of Tech., Cambridge. Radioactivity Center).

The calibration of procedures for measuring Th and Rn in breath, Ra^{224} and Ra^{226} in bone samples, and whole-body burdens of Ra^{228} is described. Data are presented on the body burdens and clinical findings for persons occupationally or therapeutically exposed to radium, mesothorium, or thorotrast. A coding system for IBM cards, based on the IBM SHARE library program, was developed for use in the comparison of data for patients with body burdens of Ra^{226} with normal individuals. Radioautograms of bone samples containing Ra indicated good agreement for measured and calculated Ra content in bone. Chromosome studies on cultures of peripheral blood from 7 patients with burdens of Ra or Th ranging from 0.2 to 1.96 μC showed an increase in the frequency of abnormal cells consistent with radiation lesions. Data are presented on the clinical status and Ra body burdens of persons exposed to Ra or MsTh 30 or more years ago. (C.H.)

37009 (NYO-9505(p.40-51)) GENERAL RADIOBIOLOGY. (Massachusetts Inst. of Tech., Cambridge. Radioactivity Center).

Results are reported from whole-body measurements of Cs^{137} in normal human subjects, measurements of whole-body and thyroid gland content of I^{131} at various times after the administration of an oral dose, and whole-body measurements of K^{40}. Preliminary experiments were performed to test the feasibility of determining in vivo bone composition through neutron activation and subsequent γ spectroscopy and the feasibility of detecting and measuring small quantities of foreign matter in the lymphatic system through neutron activation. (C.H.)

37010 (NYO-9505(p.52-8)) NUCLEAR PHYSICS. (Massachusetts Inst. of Tech., Cambridge. Radioactivity Center).

A nsec-lifetime measurement system is described for use in measurements of the half lives of excited rotational states of heavy even-even nuclei. Results of measurements on Ra^{224}, Rn^{220}, and Th^{230} are reported. An automated angular correlation system is described that was designed to investigate the spins and parities and other properties of heavy nuclides by α–γ angular correlation measurements. Measurements were made of the angular correlations of the 5.60-Mev α rays occurring in the decay of Bi^{212}. (C.H.)

37011 (NYO-9505(p.59-79)) DIFFERENTIAL UPTAKE OF ELEMENTS 88 AND 90 FOLLOWING ORAL INGES-

TION BY HUMAN BEINGS. (Massachusetts Inst. of Tech., Cambridge. Radioactivity Center).

Procedures are described for the preparation and standardization of carrier-free sources of Ra^{224} from Th^{228} and Th^{234} from U^{238}. A mock-radium paint was prepared using either Ra^{224} or Th^{234}. A procedure, named skull and crossbones (SXB), is described for whole-body counting in which part of the body is shielded. Results are presented from preliminary evaluations of the method for the determination of body burdens of Ra^{226}, Ra^{224}, and Tl^{208} using humans, dogs, and phantoms with the gastrointestinal tract shielded with Pb. Data are included from studies of the metabolism of Ra^{224} and Th^{234} in dogs following intravenous injection. (C.H.)

37012 (NYO-9505(p.80-6)) INSTRUMENTATION TECHNIQUES. (Massachusetts Inst. of Tech., Cambridge. Radioactivity Center).

The design and calibration of a 4-channel α ionization chamber for use in Rn measurements and a 4-channel α scintillation scaler for use in thoron measurements are described. A large volume scintillation chamber was designed for use in the analysis of Rn in soil gas. The design and performance of surface barrier semiconductor counters for α-particle coincidence spectroscopy are discussed. (C.H.)

37013 (NYO-9505(p.87-94)) BEHAVIOR OF RADON IN SOIL GAS. (Massachusetts Inst. of Tech., Cambridge. Radioactivity Center).

Results are reported from investigations of the primary causes of natural variations in Rn concentrations in the shallow layers of soil and in Rn flux at the earth-air interface. The effects of meteorological factors, soil moisture, and underground nuclear explosions on Rn concentration in the soil are discussed. (C.H.)

37014 (NYO-9505(p.95-111)) GAMMA-RAY SPECTRA OF SURFACE AND SUBSURFACE SOIL SAMPLES FROM THE NEVADA TEST SITE. (Massachusetts Inst. of Tech., Cambridge. Radioactivity Center).

The γ spectra were determined for approximately 140 samples of soil from 3 areas of the Nevada Proving Grounds. Surface and near-surface samples from all areas showed some Co^{60}. Other radioisotopes identified included Zr^{95}, Nb^{95}, Cs^{137}, and Y^{88}. Trace amounts of activity were observed in samples taken at depths greater than 7 ft. (C.H.)

37015 (WCAP-6015) NUCLEAR MATERIALS CONTROL SYSTEM (NMCS). PHASE II. Semi-Annual Progress Report, January 1–June 30, 1959. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). July 1, 1959. Contract AT(30-1)-2152. 115p.

The Chemistry and Chemical Engineering activities included installation and preliminary testing of a variety of in-line instruments and process instruments on a Test Loop constructed for that purpose; a few remaining instruments are in advanced stages of fabrication and procurement. The Nuclear Studies programs have been primarily concerned with developing designs and specifications for a variety of reactor instruments, a gamma-ray scanning device for irradiated fuel assemblies, and a Reactor Fuels Measurement Facility (RFMF). The latter is a critical facility designed to determine the fissile content of unirradiated fuel elements, with and without contained burnable poisons, by comparison against a standard. The activities on Special Devices included completion of predesign testing for a Doorway Monitor, the fabrication and initial testing of a Fuel Assay Scanner, and the procurement of portable radiation monitors; the design, procurement and testing of a communications system is nearly completed. The work on Security Devices and Techniques included the procurement and experimental evaluation of commercial equipment, and the design and development of a number of original security devices. (auth)

37016 (WT-792) EFFECTS OF AN ATOMIC EXPLOSION ON TWO TYPICAL TWO-STORY-AND-BASEMENT WOOD-FRAME HOUSES. Joseph B. Byrnes (Federal Civil Defense Administration, Washington, D. C.). Sept. 1953. Project 21.2 of OPERATION UPSHOT-KNOTHOLE. 69p.

The effects of an atomic explosion on typical two-story wood-frame houses and occupants thereof were demonstrated. Two houses with basements were located 3500 ft and 7500 ft from ground zero of a 16.4-kt atomic bomb exploded at 300 ft above the ground during operation Upshot-Knothole. Both houses were furnished and mannequins were placed in the dining and living rooms. Visual inspection and photography were utilized to study thermal radiation and blast effects, and film badges were placed throughout the houses to measure γ radiation. Mannequins in both houses were thrown about and severely damaged by flying glass and debris, and those in the house located at 3500 ft were broken and trapped in debris. The exterior wood on the front of the house at 3500 ft was charred from thermal radiation, the first story disintegrated, the roof and chimney broke, and other sections of the house were moved off the basement walls. The house at 7500 ft was slightly scorched, windows and doors were broken, and the house was badly damaged inside. Heavy fallout delayed the recovery of the film badges and initial γ radiation was not determined. Results indicated that a conventional wood-frame house will be severely damaged at an overpressure of 2 psi and will be destroyed at 5 psi. Damage to mannequins indicated that human beings without shelter would have been killed or seriously injured in the house 3500 ft from the blast and would have been injured in the house 7500 ft from the blast. (C.H.)

BIOLOGY AND MEDICINE

General and Miscellaneous

Refer also to abstracts 37009 and 37011.

37017 (BNL-6621) THE MICROBEAM AS A TOOL IN RADIOBIOLOGY. Howard J. Curtis (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 30p.

The science of radiobiology embraces the basic problems of biology. In order to investigate these at a cellular level in the higher plants and animals, it is necessary to apply radiation to the individual cells. This can be done in vivo only by a microbeam of protons or heavier particles. A description is given of a microbeam of 22 mev deuterons which is as small as 0.025 mm in diameter. This may be directed at discrete parts of plants and animals to irradiate very small groups of cells with accurately calibrated dosages. Using this microbeam it has been shown that in certain organs, enormous doses of radiation can be delivered to microscopic volumes without apparent cellular injury. This constitutes a method for measuring the radiation sensitivity of cells in situ, and independent of the radiation sensitivity of surrounding cells. The microbeam will simulate the biological effect of a heavy cosmic ray particle, and it is shown that these particles do not constitute a special hazard for space flight. (auth)

37018 (NYO-10589) THE LOCALIZATION OF TUMORS WITH LABELED POLYSACCHARIDE ANTIGENS. Final Report. Jack G. Makari (Muhlenberg Hospital, Plainfield, N. J.). [1963]. Contract AT(30-1)-2692. 11p.

The possibility of the localization of tumors by the use of labeled tumor polysaccharide (TPS) antigens was investigated using tritium as a label. Results are reported from studies of the uptake of TPS-H^3 by tumor tissue in culture, the metabolism of TPS-H^3 in normal and tumor-bearing mice, the localization of TPS-H^3 in neoplastic and non-neoplastic tissues after pre-treatment with various enzymes and with DNA, the use of erythrocytes and of tumor cells as carriers of TPS-H^3 to the tumor, the effects of age and other variables on the uptake of TPS-H^3 and of tritiated water by tumor and normal tissues, and the relative uptake of TPS-H^3 by various neoplastic and normal tissues in a case of metastatic carcinoma of the ovary. Selective localization to tumor tissue as compared with muscle was noted in all neoplastic tissues but the concentration of TPS-H^3 was highest in the kidneys and liver. No high extent of selective localization of TPS-H^3 to neoplastic as compared with non-neoplastic tissues was found. (C.H.)

37019 (TID-17632) MYELOBLAST TURNOVER IN NORMAL AND LEUKEMIC STATES. Alberto Monti, Mary A. Maloney, and Harvey M. Patt (Argonne National Lab., Ill. and Hektoen Inst. for Medical Research, Chicago). Oct. 1962. Contract W-31-109-eng-38. 10p. (UAC-6979)

The general pattern of leukocyte renewal was studied in acute and chronic myeloid leukemia by high resolution radioautography with tritiated thymidine. Results indicate there is a normal chronology of development in chronic leukemia, with labeled neutrophils appearing in the blood by the 5th day after tritiated thymidine injection and disappearing at approximately the normal rate. It is suggested that the apparent overproduction in this disease may be due in part to the survival of myelocytes that would normally die in bone marrow. Results are reported from preliminary studies of the kinetics of normal and leukemic myeloblasts in humans. (C.H.)

37020 (JPRS-20795) STUDIES OF RADIOACTIVE ISOTOPES (P^{32}, S^{35}, Sr^{90}, Y^{91}, AND Ce^{144}) IN MARINE BIOLOGY. Translated from Tr. Sevastopol'sk. Biol. St., Akad. Nauk SSSR, 14: 309-13; 329-33(1961). 13p. (OTS-63-31614)

37021 (JPRS-20795(p.1-6)) DISTRIBUTION OF P^{32}, S^{35}, Sr^{90}, Y^{91}, AND Ce^{144} BETWEEN SEA WATER AND BOTTOM UNDER EXPERIMENTAL CONDITIONS. A. D. Akamsin. Translated from Tr. Sevastopol'sk. Biol. St., Akad. Nauk SSSR, 14: 309-13(1961).

Results are reported from studies of the sorption of P^{32}, S^{35}, Sr^{90}, Y^{91}, and Ce^{144} by various type of marine bottom silts. Strontium-90 and S^{35} were not adsorbed from sea water, P^{32} was adsorbed to a very small extent, and Y^{91} and Ce^{144} were readily adsorbed onto the 3 types of marine bottom sediments tested. (C.H.)

37022 (JPRS-20795(p.7-12)) REPRODUCTION OF THE MASS ONE-CELLED ALGA PROROCENTRUM MICANS EHR. IN THE PRESENCE OF S^{35}. G. G. Polikarpov and L. A. Lanskaya. Translated from Tr. Sevastopol'sk. Biol. St., Akad. Nauk SSSR, 14: 329-33 (1961).

Beta particles, from S^{35} in water, were shown to have both a stimulating and an inhibitory effect on the reproduction of the mass aquatic algae Prorocentrum micans Ehr. A concentration of 10^{-6} C/l of S^{35} had a stimulating effect, whereas at 10^{-5} C/l of S^{35} and higher the cells lost their ability to divide. The inhibitory effects of beta particles were evident through 5 generations. Stable Na_2SO_4 of the same concentrations had no effect on cell reproduction. (C.H.)

37023 (JPRS-20988) POSTMORTEM DISCOVERY OF RADIOISOTOPE CONTAMINATION OF MAN. D. A. Ulitovskii (Ulitovskiy). Translated from Arkh. Patol., 25: No. 6, 67-71(1963). 7p. (OTS-63-31709)

Procedures are described that were used for postmortem determination of radioisotope contamination in a cancer patient. The source of contamination was attributed to P^{32} in $Na_2HP^{32}O_4$ given for therapeutic reasons. (C.H.)

37024 (JPRS-21086) THE USE OF THE BETATRON AND RADIOACTIVE GOLD IN COMPLEX TREATMENT OF BRAIN TUMORS. V. M. Shamon, K. N. Badmayev, A. A. Volkov, N. K. Muratkhodzhayev, A. N. Orlova, and R. V. Sinitsyn. Translated from Voprosy Neirokhirurg., No. 3, 37-41(1963). 6p. (OTS-63-31762)

Results are reported for 49 patients with brain tumors treated with fractionated betatron radiation with a total dose of 2,000 to 4,000 rads to each of 2 or 3 fields. All modern methods of tumor localization were used. Most of the patients received betatron treatment after surgical intervention wherein the boundaries of the tumor were marked with contrast tantalum powder or silver clips. Gold-198 was used in the treatment of inoperable brain tumors, with colloidal gold used for cystic forms of brain tumors and granulated preparations used for nodular forms. The combination of surgery and x-ray treatment resulted in 20 patients with no clinical signs of tumor growth after 2 years. Improvements were noted in practically all patients treated. The need for repeated surgical interventions in the post-radiation period is stressed. (C.H.)

37025 (JPRS-21171(Del.)) STUDIES IN NUTRITION. Translated from Vopr. Pitaniya, 22: No. 4, 6-24(July-Aug. 1963). 28p. (OTS-63-31803(Del.))

37026 (JPRS-21171(Del.)(p.6-13)) CAN A DETERMINATION OF THE TOTAL BETA-RADIOACTIVITY OF FOOD PRODUCTS SUFFICE? A. A. Moiseev (Moiseyev). Translated from Vopr. Pitaniya, 22: No. 4, 6-11(July-Aug. 1963). (OTS-63-31803(Del.)(p.6-13))

Factors briefly reviewed are to be taken into account in evaluation of possible radiation hazards for man due to fission products entering the body. It is shown that principal attention in controlling foodstuff contamination levels due to radioactive fallout should be focused on Sr^{90}, Cs^{137}, and I^{131}. An inference is made to the effect that the determination of the summary beta activity of foodstuffs alone, without any supplementary radiochemical and gamma spectrometric investigations, does not allow realization of an adequate sanitary and hygienic assessment of the results subsequent to inquiries into contamination of foodstuffs with radioactive fallout products and is but a sheer waste of money, efforts, and time of specialists engaged in supervising the contamination of foodstuffs with radioactive fission products. (auth)

37027 (JPRS-21171(Del.)(p.14-23)) HISTOCHEMICAL STUDIES OF LIPASE, ALKALINE AND ACID PHOSPHATASE ACTIVITIES IN THE DIGESTIVE TRACTS OF RATS ON DIFFERENT DIETS EXPOSED TO SUBLETHAL DOSES OF X-RAYS. T. Tashev and Z. Angelova. Translated from Vopr. Pitaniya, 22: No. 4, 12-19(July-Aug. 1963). (OTS-63-31803(Del.)(p.14-23))

Late changes in the activity of lipase, alkali and acid phosphatase in the liver, stomach, duodenum, small intestine and in the pancreas of rats exposed to the effect of X-rays were studied. Varying isocaloric diets, viz; that with normal protein content + 5 mg of the uterine milk, protein poor, protein enriched and that containing its normal amount + 10 per cent of the L. bulgaricum culture and when fed on an ordinary food ration were provided. Most distinct were the differences seen in the activity of lipase. It proved highest both in irradiated and control animals, kept on a diet with an increased and normal protein content, with addition of a 10 per cent L. bulgaricum culture, while its lowest level was recorded in animals, kept on a protein poor diet. Changes observed in the activity of the alkali and acid phosphatase give no definite conclusion as to the influence exerted by different nutritional patterns or by the irradiation. (auth)

37028 (JPRS-21171(Del.)(p.24-31)) THE EFFECT OF X-RAY IRRADIATION ON RIBOFLAVIN METABOLISM. M. M. Kubareva. Translated from Vopr. Pitaniya, 22: No. 4, 19-24(July-Aug. 1963). (OTS-63-31803(Del.)(p.24-31))

In rabbits subjected to a single total body x ray dose of 800 r, a short-term drop was observed in the blood riboflavin level, along with a protracted (up to 30 days) and intensive excretion of this substance together with urine. This was paralleled with a decrease in the weight of the animals and deranged correlation of blood serum fractions. A supplementary introduction to the animals of riboflavin in a dose of 0.08 mg/kg carried on for a space of 7 days prior to irradiation and 60 days thereafter, alleviated the course of the radiation sickness in the experimental rabbits. Shifts occurring in the blood protein composition and loss of weight in the animals treated with riboflavin were considerably less marked. (auth)

37029 A NEW DESIGN 6 Mev LINEAR ACCELERATOR SYSTEM FOR SUPERVOLTAGE RADIOTHERAPY. J. Haimson (Varian Associates, Palo Alto, Calif.) and C. J. Karzmark. Brit. J. Radiol., 36: 650-9(Sept. 1963).

A description is given of a new and compact megavoltage therapy system which combines a cantilevered treatment couch with an isocentrically mounted accelerator capable of rotating completely around a recumbent patient. In addition, provision is made for therapy techniques which require patient rotation. This linear accelerator system introduces a new standard of compactness and flexibility as related to patient treatment. The overall height of the accelerator is less than 240 cm while a 100 cm FSD is retained. The patient support assembly includes a plastic portal device for irradiation from beneath the couch, three-dimensional positioning of the patient, and snap-off wheel assemblies which enable the patient to be lowered to floor level on an electrically operated pedestal for large field techniques. These features ensure rapid, precise, and consistent patient set-up procedures. Representative techniques are illustrated. Use of the actual treatment couch for patient transportation is an operational convenience. The application of this accelerator system for diagnostic radiography is discussed. Physical measurements indicate a high degree of beam flatness and a surface dose of less than 20 per cent of the maximum which occurs at about 15 mm depth. High x-ray intensity permits large FSD techniques. Approximately 600 watts of electron beam power can be made available through the x-ray beam defining system by a simple conversion. Some characteristics of the electron beam are discussed to enable evaluation for sterilization and radiobiological applications. (auth)

37030 ON THE ACTION OF RADIOIODINE THERAPY ON HYPOTHYROID OPHTHALMOPATHY. S. Fazakas, Jr., and Gy. Petranyi (Univ. Medical School, Debrecen, Hungary). Endokrinologie, 44: 5-13(1963). (In German)

The effects of I^{131} doses of 2-32 mC in 33 subjects with exophthalmos are reported. Improvement or complete resolution of the eye disorder was obtained in 78%, whereas thyrostatic agents, such as thiouracil, were less effective. (BBB)

37031 A VERSATILE COBALT-60 SAMPLE IRRADIATION UNIT. SOME DESIGN FEATURES AND DOSE MEASUREMENTS. G. L. Brownell, K. Stratton, and J. L. Pinter (Massachusetts General Hospital, Boston). Phys. Med. Biol., 8: 265-77(Sept. 1963).

The design of a 5000-C double-well Co^{60} irradiation unit is described. The 5-in. dia × 8-in. high irradiation volume enclosed by the cylindrical source has access tubes for electrical and fluid connections to the sample during irradiation. The upper Pb shield and the source are motor-driven. Operation is either by manual or fully automatic control. Dose measurements were made with an Al absorbed dose calorimeter and with the ferrous-ferric system. They give $7.80 \pm 0.12 \times 10^5$ rad/hr in water (December, 1961) for the dose rate at the center of the irradiation volume. The spatial dose distribution within the irradiation chamber was mapped using a Plexiglas (polymethylmethacrylate) dosimeter. Results of calibration of the radiation-induced optical absorption at 370 mμ against the ferrous-ferric system showed that the plastic dosimeter was linear with dose of Co^{60} γ rays up to 1.2×10^6 rads. (auth)

37032 SOME APPLICATIONS OF POWER LAW ANALYSIS TO RADIOISOTOPE STUDIES IN MAN. J. Anderson, S. B. Osborn, R. W. S. Tomlinson, and I. Weinbren (Univ. of London). Phys. Med. Biol., 8: 287-95(Sept. 1963).

The specific activity of Ca in the blood following intra-

venous injection of Ca^{47} was studied in six normal subjects, three patients with osteoporosis, and eight patients with secondary cancer of bone. Measurements were made from 2 min after injection to 8 or 10 days later. When the results were plotted on log-log graph paper, they followed 2 or 3 straight lines (i.e., power functions), the pattern of which was characteristic of the bone condition concerned. Many other data can be similarly represented more simply by power functions than by exponentials. It is suggested that although this finding is empirical, it does nevertheless give additional meaning to the results obtained. (auth)

37033 THE DOSE-RATE FROM A SPHERICAL SOURCE WITH SELF-ABSORPTION. J. B. Whittaker (Univ. of Birmingham, Eng.). Phys. Med. Biol., 8: 309-18 (Sept. 1963). (AERE-R-4106)

The dose rate at any point outside a spherical homogeneous radioactive source is calculated assuming exponential absorption both in the surrounding medium and in the source. The integral expression so obtained is used to derive the dose rate on the surface explicitly. Numerical values and approximate expressions are presented in the special cases of the source in a nonabsorbing medium and a medium of absorption coefficient equal to that of the source. The errors involved in the various approximations are given. An estimation of the effect of scattered radiation by means of build-up factors is discussed. (auth)

37034 A REMOTE-CONTROL APPARATUS FOR IRRADIATION OF MICE AND RATS. Patricia J. Lindop and J. R. Musgrove (St. Bartholomew's Hospital, London). Phys. Med. Biol., 8: 325-31(Sept. 1963).

An apparatus is described which enables 48 mice to be irradiated in batches of four, each container with animals being brought consecutively into the irradiation area by remote control. The apparatus also enables one to control the gas breathed by the animals during irradiation, its rate of flow, and temperature. (auth)

37035 THYROID CANCER AND TREATMENT OF HYPERTHYROIDISM WITH RADIOIODINE. Adolf F. Lindblom. Svenska Lakartidn., 59: 1004-6(Mar. 29, 1962). (In Swedish)

Evidence relating to the induction of thyroid cancer by I^{131} is reviewed. (BBB)

37036 INSTALLATION OF TELECOBALT THERAPY FOR LOCALIZED AND TOTAL IRRADIATION OF PATIENTS. C. M. Lalanne and J. Surmont. Tech. Hop. (Paris), 18: Suppl., 45-51(Jan. 1962). (In French)

Problems encountered in installation of a Co^{60} unit, characteristics of the device, dosage factors, and applications in radiotherapy are discussed. (BBB)

37037 A SEARCH FOR BIOLOGICAL EFFECTS OF MAGNETIC FIELDS. Adolph Eric Smith. Thesis, East Lansing, Mich., Michigan State Univ., 1963. 111p.

Results are reported from a study of the effects of magnetic fields on antigen-antibody reactions as evidenced by the agglutination of human erythrocytes with emphasis on the Rh-blood-group system. The significance of magnetic fields for possible elucidation of the agglutination mechanism is discussed. (C.H.)

37038 LEUKAEMOGENESIS—ROLE OF VIRUSES AND CYTOLOGICAL ASPECTS. Arthur C. Upton (Oak Ridge National Lab., Tenn.). p.67-82 of "Cellular Basis and Aetiology of Late Somatic Effects of Ionizing Radiation." London and New York, Academic Press, 1962.

The presence of filterable leukemogenic agents in the tissues of irradiated mice and in those with radiogenic leukemia implicates viral mechanisms in radiation leukemogenesis. The respective roles of radiation and virus in leukemogenesis cannot yet be defined, but the available data suggest that murine leukemia evolves through a multistage process requiring the interaction of virus, host cells, and host. In such a complex system, radiation may act in several ways, one of them being to activate a latent leukemogenic virus. The basis for the relatively long induction period, however, in spontaneous and radiation leukemogenesis remains an enigma. Evidence points to the possibility that the same virus may induce different hematologic forms of leukemia in irradiated and non-irradiated individuals, depending on the constitution and physiological condition of the host. The occurrence of specific abnormalities of a single human chromosome (probably No. 21) in chronic myelogenous leukemia and in Down's syndrome, which carries an increased propensity to leukemia, suggests that cytogenetic changes may be of causal significance in human leukemogenesis. Data on the frequency of spontaneous and radiation-induced chromosome breakage, however, argue against a simple one-break aetiologic mechanism in the pathogenesis of the disease. On the basis of tracer studies, the growth of leukemia cells is not characterized by abnormally rapid cell division. Precise details of the kinetics of leukemic growth remain, however, to be elucidated. (73 references.) (auth)

37039 RADIOISOTOPES IN CARDIOVASCULAR DISEASE. Charles K. Friedberg and Solomon Silver, eds. New York, Grune and Stratton, 1962. 167p.

A series of articles is presented that cover various aspects of the use of radioisotopes in biochemical and physiologic studies of blood circulation and in the diagnosis and treatment of cardiovascular diseases. These papers were originally published in "Progress in Cardiovascular Diseases" in the May and July issues in 1962. (C.H.)

37040 THE USE OF RADIOISOTOPES IN CLINICAL MEDICINE AND MEDICAL RESEARCH. F. C. Heagy (Ontario Cancer Foundation, London and Univ. of Western Ontario, London). 7p. (CONF-9-26)

From Canadian Nuclear Association, International Conference and Future Development of Power Reactors and on Radioisotopes, Montreal, May 1963.

Applications of radioactive isotopes in medical and clinical research are reviewed, with emphasis on uses of I^{131} in the diagnosis of thyroid tumors. (C.H.)

37041 ON THE ACTIVITY OF THE INTERNATIONAL ATOMIC AUTHORITY, VIENNA, IN THE FIELD OF RADIOLOGY AND RADIOBIOLOGY. R. C. Jaeger. 23p. (CONF-47-1). (In German)

From German Atom Forum Conference on Atomic Radiation in Medicine and Technology, Munich, Jan. 1963.

A brief indication is given of the work of the IAEA with respect to publications, setting up basic safety standards for radiation protection, and the coordination of scientific and technical work. Then the specific work of the agency in the field of radiology and radiobiology is illustrated by a discussion of phantom studies on radioiodine uptake, toxicity studies of radioisotopes, and dosimetry. (J.S.R.)

Biochemistry, Nutrition, and Toxicology

37042 (LADC-5554) THE EFFECT OF ENVIRONMENTAL TEMPERATURES ON THE RETENTION OF

CESIUM^{137} BY MICE. J. E. Furchner and C. R. Richmond (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7504-eng-36]. 13p.

Three groups of 12 mice each were maintained at environmental temperatures of 34, 22, and 5°C for a period of about 7 weeks after an intraperitoneal injection of Cs^{137}. Periodic assay of the activity in the whole body and excreta showed that as environmental temperature decreases the excretion of Cs^{137} increases, probably as a result of the increased metabolic rates associated with low temperatures. (auth)

37043 TRANSFER OF Cd^{115} ACROSS THE PERICARDIUM OF DOGS. Tsunekazu Takashina, Ralph Lazzara, James A Cronvich, and George E. Burch. Am. Heart J., 64: 431-2(Sept. 1962).

Transfer of a radioisotope of cadmium, essential for function of some enzymes, was studied after instillation of the isotope into the pericardial cavity (5.5 mg/ml in Ringer's solution). The mean rate of transfer was 0.176 $\mu g/cm^2/min$. This represents a daily bidirectional rate of transfer of ~150 mg for the dog. The rate is slower than that previously found for D_2O, H^3, Cl^{36}, Na^{22}, or Mg^{28}. (BBB)

37044 EXCRETION OF PLUTONIUM FOLLOWING ACCIDENTAL SKIN CONTAMINATION. B. A. J. Lister, A. Morgan, and R. J. Sherwood (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Health Phys., 9: 803-15(Aug. 1963). (AERE-R-4064)

An extensive study has been made of the fecal and urinary plutonium excretion from two subjects who sustained high levels of contamination on the uncut skin of the hand from accidental contact with acid plutonium solutions. In one case, where the contaminant was mixed plutonium isotopes in aqua regia and nitric acid, the measurements reported covered 150 days. In the other case, excretion after contamination with a solution of plutonium in dilute hydrochloric acid containing EDTA and a detergent was followed for 110 days. The excretion patterns show marked differences from the human experimental data published by Langham, particularly in the high and variable amount of plutonium excreted in feces relative to urine. The excretion data are supplemented in one case by a series of measurements on the levels of skin contamination, by exploratory body radioactivity measurements and by a few inconclusive blood plutonium analyses. Attempts were made to estimate the body burdens in various ways. The wide variation of these estimates indicates the uncertainties in predicting body burden from excretion data. The present study gives no indication as to the major site of deposition of the plutonium. (auth)

37045 EXTRATHYROIDAL GAMMA DOSE FROM THE INTAKE OF MILLICURIE LEVELS OF IODINE-131. Daniel N. Tapper and C. L. Comar (Cornell Univ., Ithaca, N. Y.). Health Phys., 9: 817-26(Aug. 1963).

The fluorod dosimeter system was used to measure the gamma exposure dose from mc levels of I^{131} to the neck, stomach, small intestine, kidney, bladder, and gonads of euthyroid and thyroidectomized dogs. The retention kinetics of these levels of I^{131} were found to differ from that of tracer observations; as a result of I^{131} thyroid ablation, large amounts of the radionuclide rapidly left the body. The retention in extrathyroid regions, representing 76 per cent of the total effective retention, was not appreciably affected by the range in initial thyroid status represented. The measured gamma exposure doses were several times higher than predicted by the usual models. This was attributed to heterogeneity in I^{131} distribution within the extrathyroid regions. (auth)

37046 DETERMINATION OF CARBON-14 IN PLANT MATERIAL BY WAFER COUNTING. J. R. Corbett and Charles S. Miller (Texas Agricultural and Mechanical Coll., College Station). Nature, 199: 1106-7 (Sept. 14, 1963).

The value of the absorption coefficient of carbon-14 in cotton-seed kernels was estimated, and a self-absorption curve was constructed. Results indicated that the usually accepted value of the coefficient (0.29) is approximately correct. If an absolute quantitative measurement of the amount of carbon-14 present in a wafer of pressed plant material is required, it appears that the suggested calibration curve is more accurate than equations describing the radiation behavior at infinite thickness. (H.M.G.)

37047 INFLUENCE OF CALCIUM PHOSPHATE ON THE ABSORPTION OF RADIOACTIVE STRONTIUM. R. S. Bruce (Medical Research Council, Harwell, Berks, Eng.). Nature, 199: 1107-8(Sept. 14, 1963).

To determine the period during which a protective effect against strontium-85 uptake by rats could be obtained by bone-meal feeding, the stock diet containing 10 percent bone meal was restored to fasted rats at various intervals after administration of strontium-85. Twenty-four hours after receiving the strontium, rats were killed, and strontium-85 was assayed in the residual carcass, urine, gut, and feces. It was shown that reduction in absorption and retention after 24 hr was greatest for rats that ate within a few minutes of receiving the dose. Absorption increased at further intervals until, at one hour, ingestion of the diet had little influence on the proportion of the dose absorbed. It is thus concluded that calcium phosphate might prove a useful, safe means of reducing absorption after the accidental ingestion of radioactive strontium by man. (H.M.G.)

37048 UTILIZATION OF RADIOSULPHATE BY HIGHER PLANT TISSUES. S. K. Sinha and E. A. Cossins (Univ. of Alberta, Edmonton, Can.). Nature, 199: 1109 (Sept. 14, 1963).

A variety of higher plant materials was examined for the incorporation of sulfur-35 into the amino-acid fraction. Ten-day-old radish seedlings were severed at the soil level, and the hypocotyls were placed in buffered solutions of radiosulfur. Samples of the seedlings were placed in the dark and in the light, and the uptake and incorporation of radiosulfate into amino acids were followed over a period of one hour. Leaves, hypocotyls, and cotyledons of radish seedlings were found to show a rapid incorporation of the radiosulfate into amino acids that was not appreciably affected by illumination. Although the incorporation was not markedly stimulated by additions of TPN or by a system producing reduced TPN, additions of ATP caused a five-fold increase in the sulfur-35 content of the amino-acid fraction as compared to the extracts where cofactor additions were not made. (H.M.G.)

37049 EFFECT OF HYPOPHYSECTOMY AND THIOUREA TREATMENT ON RADIOPHOSPHORUS METABOLISM IN GOLDFISH, CARASSIUS AURATUS L. P. N. Srivastava (Univ. of Rajasthan, Jodhpur, India). Naturwissenschaften, 50: 528-9(1963). (In English)

Goldfish, Carassius auratus L., were hypophysectomized. One month after the operation, hypophysectomized fish were divided into two groups, one of which was maintained in 0.3% thiourea solution. Control fish were also divided into two groups and maintained in 0.3% thiourea solution and fresh water. After two weeks P^{32} was added in all the aquaria. Hypophysectomized fish maintained in fresh water utilized 39% of the P^{32} in five days and the controls utilized 41% (the difference is not statistically

significant). Hypophysectomized fish treated with thiourea utilized only 27% P^{32} whereas the controls maintained in thiourea utilized 53%. This confirmed that increased P^{32} utilization in thiourea solutions was caused by thyroid stimulation from the increased output of endogenous thyroid-stimulating hormone by the pituitary gland. (M.C.G.)

37050 ON THE PROBLEM OF SIDE EFFECTS DUE TO CANCER CHEMOTHERAPY AMONG ATOMIC BOMB SURVIVORS. Shigeru Iwamori, Yukuo Imada, Nobuo Nagata, Katsumi Nishida, Hideaki Matsumura, and Tsunenori Nakamae (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 4, 87-94(1963). (In Japanese)

Two cases of cancer in which administration of anticancer agents resulted in persistent bleeding similar to that in radiation sickness are reported: symptoms and progress are discussed. Attention is given to the difference in the frequency of side effects of anticancer chemotherapy for cancer patients exposed to radiation from the atomic bomb as compared to those not exposed. Side effects of anticancer chemotherapy on the digestive and hematopoietic systems were more frequent among those patients exposed to the bomb. It is suggested that survivors with malignancy might be suffering from latent hematopoietic disturbance. (H.M.G.)

37051 MUSCLE ELECTROLYTES IN MAN DETERMINED BY NEUTRON ACTIVATION ANALYSIS ON NEEDLE BIOPSY SPECIMENS. Jonas Bergstrom (S: Teriks Sjukhus, Stockholm). Scand. J. Clin. Lab. Invest., 14: Suppl. 68, 110p.(1962). (In English)

Methods are described whereby very small amounts of alkali and other metals may be accurately assayed in minute tissue samples by submitting them to a neutron flux and, after suitable decay periods, measuring certain isotopes so formed. (BBB)

37052 INHALATION RESEARCH WITH CARRIER-FREE $Y^{91}Cl_3$ IN GUINEA PIGS. W. Schiessle, I. Schmidtke, K. Philipp, and K. Fibich (Universität, Freiburg i. B.). Zentr. Biol. Aerosol Forsch., 11: 12-36(Apr. 1963). (In German)

The uptake, distribution, and elimination of Y^{91} were investigated in 104 guinea pigs that inhaled carrier-free Y^{91} for 30 min. The study extended for a half year. The following results were obtained. The dose received by the animals was 3 μC Y^{91}. Approximately half reached the lungs, the other half, the gastrointestinal tract. The uptake of the Y^{91} deposit in the lungs occurs in several phases. 64% of the initial dose is detectable after 4 hours, 54% after one day, 25% after eight days, 13% after 28 days, and 2.5% after half a year. The distribution in the body of the Y resorbed in the lungs takes place in the same pattern as after intravenous injection. A transient accumulation in the parenchymatous organs precedes the final incorporation into the bones, which occurs slowly after inhalation. The biological half life for Y in bones was estimated to be over a year. The elimination occurs chiefly through the gastrointestinal tract. The ratio of the enteric to the renal elimination is 10:1 after four months. At this time 80% of the incorporated Y had been eliminated. The biological half life in the total organism is between 3 and 4 days, in the lungs between 7 and 8 days, and in the bones over one year. It was concluded from the studies that with inhalation of higher doses of Y^{91}, principally the lungs, the branching points of the bronchi and hilus lymph nodes, and, after the first days, the gastrointestinal tract, are charged. (tr-auth)

Fallout and Ecology

37053 (FFIK-IR-K-251) DISTRIBUTION OF STRONTIUM-90 AND CESIUM-137 IN NORWAY SPRUCE (PICEA ABIES). B. Ottar and T. Wik (Norway. Forsvarets Forskningsinstitutt, Kjeller). Nov. 15, 1962. 37p.

The content of Sr^{90} and Cs^{137} in 1-m sections of two trees, Picea abies, and in the root and the top of one of the trees have been determined by radiochemical analysis. The resulting values have been used for calculation of Sr^{90} and Cs^{137} in stem, branches, needles, twigs, and root of the whole tree. The distribution among bark, wood, needles, and twigs has also been evaluated. The Sr^{90} and Cs^{137} content in pC/kg dry weight of the stem and the cubic mass of spruce per decare of mean mixed forest in Norway have been used to obtain an indication of the contribution of Sr^{90} and Cs^{137} in mC/km^2 from spruces to the forest. (auth)

37054 (FFIK-IR-K-253) A STUDY OF Sr-90 AND Cs-137 IN NORWAY. 1957–1959. L. Lund, O. B. Michelsen, B. Ottar, and T. Wik (Norway, Forsvarets Forkningsinstitutt, Kjeller). Nov. 15, 1962. 129p.

Precipitation, soil, vegetation, and drainage water were systematically sampled and analyzed for Sr^{90} and Cs^{137} in three precipitation basins in South Norway. In addition peat soil and plants from 32 other localities in South and North Norway were analyzed to assess the over-all fallout level in Norway. In the three precipitation basins the results gave a picture of the distribution and transportation of Sr^{90} and Cs^{137} in water, soil, and vegetation under different seasonal conditions. (auth)

37055 (ORNL-3409) STATUS REPORT NO. 4 ON CLINCH RIVER STUDY. R. J. Morton, ed. (Oak Ridge National Lab., Tenn.). Sept. 25, 1963. Contract W-7405-eng-26. 125p.

The status of radioactive contamination of the Clinch and Tennessee River systems from Nov. 1961 to April 1962 is reviewed. Data are included from studies on the fate of radioactive materials discharged to the Clinch River by the Oak Ridge National Laboratory, the mechanisms of dispersion of radionuclides released to the river, the direct and indirect hazards of waste disposal practices during the period, an evaluation of the over-all usefulness of this river for radioactive disposal purposes, and an evaluation of long-term monitoring procedures. The management of liquid wastes at ORNL is discussed and results are reported from studies on the accumulation and movement of radionuclides in White Oak Creek basin, the contamination of river biota, hydrologic measurements and analyses, measurements of radioactivity in the river system and in community water systems downstream from the Clinch River, and calculation of estimated radiation dosages from drinking Clinch River and Tennessee River water or immersion in the water at various downstream points. Results are included from a preimpoundment study of ecological conditions of Melton Hill Lake and estimates of the effects of Melton Hill Lake and power releases from Melton Hill Dam on hydrologic conditions in the river system. (C.H.)

37056 (FTD-TT-63-664) ON THE RADIOACTIVE CONTAMINATION OF THE BIOSPHERE AND MEASURES OF COMBATING THESE CONTAMINATIONS. N. V. Timofeev-Resovskii (Timofeyev-Resovskiy). Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural'sk. Filial, No. 22, 7-16(1962). 17p.

The biological consequences of contamination of the biosphere by radioactive particles are reviewed. The neces-

sity for the protection of air, water, soil, and living organisms against wastes from atomic energy industries is stressed. (C.H.)

37057 (JPRS-21109) THE USE OF RADIOACTIVE ISOTOPES IN THE FISHING INDUSTRY. G. S. Karzinkin. Translation of p.1-73 from "Ispol'zovanie Radioaktivnykh Izotopov v Rybnom Khozyaystve," Moscow, 1962. 77p. (OTS-63-31775)

Applications of radioisotopes as tracers in studies of metabolism and ecology of fish are discussed. It is pointed out that when fish are to be released in natural waters, a radioisotope that is fixed biologically in bone or other inedible parts should be used. Results are reported from studies using Ca^{45}, P^{32}, Sr^{89}, Y^{91}, Ce^{144}, Fe^{59}, Co^{60}, Zn^{65}, I^{121}, C^{14}, and S^{35}. Applications of radioisotopes in mass fish labeling programs are discussed. (C.H.)

37058 BARIUM CONTENT OF DIFFERENT PARTS OF THE CHOROID OF THE BOVINE EYE. Kirste Kostial-Simonovic (Medical Research Council Radiobiological Research Univ., Harwell, Berks, Eng.) and Antoinette Pirie. Nature, 199: 1007(Sept. 7, 1963).

The Ba content of different parts of the choroid of the bovine eye was determined by activation analysis. Results indicate that Ba is associated with the pigmented choroid. (C.H.)

37059 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 31, OCTOBER-DECEMBER 1962. Tokyo, The Japan Meteorological Agency, 1963. 112p. (In English and Japanese)

Data are presented on radioactivity in samples of rain water and atmospheric dust collected in Japan during 1962. Microbarographic records produced by USSR and USA nuclear tests in 1961 and 1962 are included. (C.H.)

Radiation Effects on Living Tissues

37060 (BNL-6600) RADIATION EFFECT ON THE RNA METABOLISM OF THE CENTRAL NERVOUS SYSTEM. Y. L. Yamamoto, L. E. Feinendegen, and V. P. Bond (Brookhaven National Lab., Upton, N. Y.). Dec. 21, 1962. Contract AT-30-2-GEN-16. 16p.

Tritiated cytidine was used to study autoradiographically the effect of 500- and 15,000-r x ray (250-kvp) irradiation on RNA synthesis and metabolism in the mature fully developed central nervous system of the rat. The label was injected intravenously immediately following irradiation. Local irradiation of the head and 500-r irradiation of the total body resulted in a depression of cytoplasmic RNA labeling, 24 to 48 hr after exposure in the choroid plexus cells, pyramidal cells (Rose's area h_3) in the hippocampus, neurons in the third layer of the postcentral cortex, and Purkinje cells of the cerebellum. Labeling of nuclear RNA immediately after irradiation was, however, not sufficiently different in experimental and control animals to account for the subsequent difference in the cytoplasmic labeling. The decline with time of nuclear RNA labeling was rather parallel in all groups. Five hundred r irradiation to the total body resulted in a greater depression of cytoplasmic RNA labeling in the brain cells than did 500 r localized to the head. The described responses were of similar magnitude in the different neurons examined. There were no morphological changes in the cell systems described following irradiation with 500 r. (auth)

37061 (BNL-6608) THE EFFECTS OF 250-KV X-RAY ON THE DOG'S PANCREAS: MORPHOLOGICAL AND FUNCTIONAL CHANGES. John Archambeau, Melvin Griem, and Paul Harper (Brookhaven National Lab., Upton, N. Y.). [196?]. Contract AT-30-2-GEN-16. 28p.

The pancreas of nine dogs was surgically isolated to the right side of the abdomen and irradiated with a total dose of 4500–5000 rads fractionated over 30 days. At the end of irradiation, and at one month, two months, and five months after irradiation, the histological changes demonstrated a progressive interstitial fibrosis and scarring which distorted the regular architecture. The acini were reduced in number and often distorted by the fibrosis but were morphologically intact. The islets showed no histological change. Beta and alpha cells were present. One dog with a modified total pancreatic fistula survived two weeks after receiving a tissue dose of 4500 rads to the pancreas fractioned over 24 days. The total 24-hour secretory volume, and the secretory volumes following secretin and Mecholyl stimulation were unchanged during and following irradiation. The serum and pancreatic secretion electrolytes, fasting blood sugar and glucose tolerance curve were within normal limits. However, the elevated serum amylase decreased, while the concentration of amylase of the pancreatic secretion increased. The function studies confirm the morphological findings that the pancreas is radio-resistant. (auth)

37062 (BNL-6649) ANTIBODY FORMATION BY TRANSPLANTED BONE MARROW, SPLEEN, LYMPH NODE AND THYMUS CELLS IN IRRADIATED RECIPIENTS. Richard D. Stoner and Victor P. Bond (Brookhaven National Lab., Upton, N. Y.). Jan. 14, 1963. Contract AT-30-2-GEN-16. 32p.

Immunological competence of immunized mouse bone marrow, spleen, lymph node, and thymus cells was demonstrated when specific recall tetanus antitoxin responses were elicited after transfer of these cells to isologous irradiated mice or rats. Lesser amounts of antibody were obtained as the genetic strain distance was increased between the relation of donor and host in the parental to F_1 and in the homologous combination within the same species. It was not possible in the heterologous situation to elicit significant amounts of antibody from rat bone marrow and other lymphoid cells following their transplantation into irradiated mice. Minimal but not significant antibody responses were elicited from cells obtained from immunized rat spleen and thymus tissue. In a few experiments, it was possible to elicit antibody formation from a buffy coat suspension of circulating white cells following their transfer to irradiated recipients. Isologous nonimmunized bone marrow did not stimulate or hasten recovery of the ability to elicit secondary antibody responses in previously immunized irradiated mice. The capacity to elicit primary antibody responses to tetanus toxoid was depressed in parental-bone-marrow-protected F_1 mice when these chimeras exhibited varying degrees of secondary disease. The depression of primary antibody responses in irradiated F_1 mice given parental bone marrow provides evidence for a donor mediated immunological depression of antibody synthesis by host-lymphoid tissues. (auth)

37063 (NYO-10616) BIOCHEMICAL MUTANTS OF HIGHER PLANTS. Final Report. [Period Covered]: February 1, 1961–May 31, 1963. Trevor Robinson (Massachusetts. Univ., Amherst). Contract AT(30-1)-2736. 4p.

Exposure to Co^{60} γ radiation at a dose of 6 to 7 kr resulted in only one biochemical mutant in over 10,000 duckweed plants (Lemna perusilla). (C.H.)

37064 (TID-18657) EFFECTS OF IONIZING RADIATION ON LIPIDS OF FISH. Final Summary, October 1961–September 1962. Virginia F. Stout (Fish and Wildlife Service. Technological Lab., Seattle). Apr. 1963. Contract AT(49-11)-2058. 19p.

Alteration of lipids may be a problem with radiopasteurized seafoods as a result of actual changes in lipid during irradiation, loss of stability during irradiation resulting in later more rapid deterioration in storage, or accelerated deterioration during storage at a low temperature, which arrests bacterial action and thereby increases the O tension available for oxidative alteration of the lipid. The behavior of highly unsaturated fatty esters, typical models of fish lipids, in the presence of pasteurizing levels of Co^{60} γ rays was studied to anticipate the role of fish lipids in the preservation of fishery products by radiation. A method of obtaining large quantities of 85 to 90% concentrates of docosahexaenoic acid was developed. When purified methyl docosahexaenoate was irradiated in vacuum, no gross alterations were observed. The stability of the ester to O absorption in the pure state and in the presence of chemicals in fish is being investigated. (auth)

37065 (TID-19407) STUDIES ON THE MECHANISM OF RADIOSENSITIZATION OF MAMMALIAN CELLS BY EXPOSURE TO HALOGENATED PYRIMIDINES. Progress Report. Marvin A. Rich (Albert Einstein Medical Center, Philadelphia). [1963]. Contract AT(30-1)-3120. 13p.

The effects of cordycepin on the radiosensitivity of mammalian cells in tissue cultures was investigated. Emphasis was placed on the mechanism by which starvation induces sensitivity to x radiation. Results are reviewed from studies on the role of 5-bromodesoxyuridine (BrUDR) in the radiosensitization of mammalian cells. The mechanism of the radiosensitization of mammalian cells by purine and pyrimidine analogs is discussed. (C.H.)

37066 (JPRS-20960) TESTIS INJURY IN MATURE MICE AS A RESULT OF SINGLE AND FRACTIONAL IRRADIATION DURING THE PERIOD OF EMBRYONIC DEVELOPMENT. N. N. Kuznetsova. Translated from Zh. Obshch. Biol., 24: 221-5(1963). (OTS-63-31697)

A study was made of the effects of single or fractionated doses of x radiation during fetal development on testicular development in mice. No reduction in testicular injury was observed when 100 r was delivered in a fractionated dose. A dose of 200 r had more effect on testicular development when delivered on the 16th day of development than did the same dose delivered on the 17th day of development. Summation of testicular injury was observed in all variants of fractionated exposure tested. (C.H.)

37067 (JPRS-20964) STUDIES OF PROTECTION OF MAMMALS AGAINST RADIATION. A. Ya. Grayevskii (Grayevskiy), N. F. Barakina, M. M. Konstantinova, and I. B. Smirnova. Translated from Zh. Obshch. Biol., 24: 182-93(1963). 18p. (OTS-63-31698)

Albino mice were given a single whole-body dose of x radiation. Subcutaneous injections of AET, cysteamine, cystamine, adrenalin, and sodium nitrate were administered prior to irradiation in doses previously determined to give maximum protection. Oxygen tension in tissues, serving as an index of radiosensitivity of the mice, was measured by the polarographic method, measurements being taken in the spleen. In additional tests the protective effectivity of AET was studied under reduced oxygen tensions. As a criterion of the protective effectiveness in all of the tests, a 30-day survival time and average lifespan of the animals that died were used. In experiments where the small intestine was investigated as criteria of radiation injury and protective effect of substances (AET and sodium nitrate), the cells along the midline of the crypts were studied: this group of mice received doses of 700 and 1300 r. When bone marrow sensitivity tests were performed, the number of cellular elements on a slide served as the criterion of injury. Results indicate that breathing pure oxygen during irradiation did not affect radiosensitivity of the animals. The prophylactic injection of AET, cysteamine, and cystamine increased the survival rates of mice by 18, 32, and 39%, respectively. Extent of the protective action was uninfluenced by degree of oxygen tension in the cells; however, the anti-radiation effect of adrenalin was distinctly reduced in the presence of pure oxygen. Analogous reduction in anti-radiation effect was noted with inspiration of oxygen when sodium nitrate was administered. Anti-radiation effectivity of AET in combination with hemic hypoxia showed that the combination is superior to that of carbon monoxide alone, and an even more pronounced increase in protective effect was noted when AET was combined with hypoxic hypoxia. Data are included on the effect of protective substances on morphological changes in radiosensitive organs. (H.M.G.)

37068 (JPRS-20997) NUCLEIN METABOLISM IN REGENERATION OF SKELETAL MUSCULATURE UNDER VARIOUS CONDITIONS OF ROENTGEN IRRADIATION. E. (Ye.) V. Dmitrieva (Dmitriyeva). Translated from Arkh. Anat., Gistol. i Embriol., 44: No. 6, 40-7(June 1963). 13p. (OTS-63-31716)

The role of nuclein metabolism in regenerating muscle fibers was studied in 14 mature albino rats. Six of the animals were given a total-body irradiation of 1000 r, four received a single localized dose of 6000 r to the right leg and foot, and four served as controls. Forty-eight hours after irradiation the rats were sacrificed, and a standard transverse section of the anterior tibial muscle was performed. Radioactive phosphorus in the form of disodium phosphate (3 mC/g body weight) was injected subcutaneously in all three groups 24 hr prior to destruction. Uptake of P^{32} was studied on autographs that were exposed for seven days. No difference in P^{32} uptake by irradiated and non-irradiated animals was apparent. Three days postirradiation RNA and DNA metabolism in non-irradiated rats and RNA metabolism in irradiated rats are higher in the myosymplasts than in the transition zone. The reduction of nuclein metabolism in regenerating muscle fibers was observed in irradiated animals and found to be dose-dependent. It is significant that radioinduced inhibition of nuclein metabolism levels off in time. Increase in phosphoprotein uptake by the transition zone and myosymplasts at the first stage and decrease at the last stage in both experimental series reflects an increase then a decrease in protein synthesis. The initial increase is perhaps a manifestation of a specific tissular reaction to the effect of ionizing radiation related to increase in size of nuclei and cellular bodies. Increase was observed in the volume of nuclei and nucleoli of the regenerating muscle fibers in irradiated animals. (H.M.G.)

37069 (JPRS-21170(Del.)) CYTOCHEMICAL STUDIES OF GLYCOGEN IN THE CENTRAL NERVOUS SYSTEM OF THE FROG AFTER GAMMA-IRRADIATION. A. L. Shabadash, S. O. Yenenko, and L. V. Orlova. Translated from Arkh. Anat., Gistol. i Embriol., 44: No. 5, 26-36(May 1963). 17p. (OTS-63-31802(Del.))

Histochemical studies of glycogen in the spinal cord and medulla of the frog showed the rapid (3 to 6 hr) reduction in the total glycogen content. Cytochemical reactions of motor nerve cells to irradiation are characterized by th-

greatest glycogen reduction. Reduction of the reserve glycogen in the neuroglia is not synchronized with the changes in the polysaccharide level in specific neurons. Loading the animal experimentally with glucose contributes to the synthesis of glycogen in the neuroglia but does not prevent a considerable reduction of it in the motor neurons. In frogs that live a long time (after a radiation dose equal to 1000 r) a considerable reduction of glycogen in the neurons was determined by the 30th to 32nd day, which should be considered a deficiency of the substrate for production of macroergic compounds. A compensatory increase of glycogen in the neuroglia is evidently responsible for the survival of the nervous system (and hence of the entire organism) under conditions of a distorted metabolism. The additional administration of glucose plays a beneficial role in the survival of the irradiated organisms. (auth)

37070 GERMINATION OF THE SEEDS AND METABOLISM OF ASH SEEDLINGS (FRAXINUS EXCELSIOR) AFTER TREATMENT OF THE SEEDS WITH RADIOPHOSPHORUS (P^{32}) SOLUTIONS. C. Huluta, Corina Iordache, H. D. Schell, O. Constantinescu, and V. Benea (Institutul de Cercetari Forestiere, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Biochim., 4: 527-36(1961). (In Romanian)

The effect of β radiation on ash seeds was studied by immersing them in solutions of $Na_2HP^{32}O_4$, with specific activities of 0.25 to 1.0 mC/l, for 24 to 336 hr. Germination of the seeds was reduced 5 to 70% by treatments with various doses, but not in a dose- or time-dependent fashion. The greatest reduction (74%) was observed after 336-hr incubation with 0.75 mC/l. In contrast to nonirradiated controls, seedlings from seeds treated with P^{32} showed a higher carbohydrate content at the early stage of growth and an increase of phosphorus and nitrogen content at later stages of growth, particularly after irradiation with the lower doses. However, no stimulation of seedling growth was noted as a result of seed irradiation. No other biochemical differences in the seedlings after irradiation as seeds could be detected. (BBB)

37071 EFFECT OF Co^{60} GAMMA RADIATION ON CATALASE. L. M. Buruiana and V. Pavlu (Facultatea de Medicina Veterinara, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Biochim., 5: 517-25(1962). (In Romanian)

Catalase, isolated in crystalline form from equine, porcine, and avian liver and from equine erythrocytes was dissolved in 0.1M phosphate buffer at pH 7.4 and exposed to Co^{60} γ radiation at a dose rate of 5 mr/hr. Changes in the activity of the enzyme were studied polarographically after 30-min (2.5 mr) irradiation. Polarograms were obtained with a solution of hydrogen peroxide at 8.8×10^{-4}M, and with the same solution after addition of native or irradiated peroxidase. The amplitude of the polarographic half-wave, particularly at lower voltages, was greater for the irradiated than for the native enzyme for liver, whereas it was smaller in the case of the erythrocyte enzyme. These results indicate that the liver enzyme of three species was inactivated by γ radiation, while red cell catalase was activated by the same treatment. Similar evidence of activation of red cell catalase was obtained when it was shaken with a 1:1 mixture of chloroform and ethanol. The divergent behavior of liver and erythrocyte catalases toward irradiation is discussed in terms of the differences in the electronic structure of their prosthetic heme groups. (BBB)

37072 EFFECTS OF DISINTEGRATIONS OF PHOSPHORUS-32 INCORPORATED IN THE YEAST SACCHAROMYCES CEREVISIAE. I. INDUCTION OF A MUTATION TOWARD RESISTANCE TO THE LETHAL EFFECT OF X RAYS. E. Moustacchi and H. Marcovich (Institut Pasteur, Paris). Ann. Inst. Pasteur, 103: 841-65(Dec. 1962). (In French)

The effects of P^{32}, added as H_3PO_4 to the culture medium, and of x rays, applied at rates of 15 to 60 kr/min, were tested on haploid and diploid strains of the yeast. The survival curve of haploid yeast cells to P^{32} decay was exponential. No tailing off of the dose-response curve was seen, contrary to what occurs with x rays. The P^{32} lethal effect was not modified by starvation, which decreases the RNA content of the cells. The site sensitive to P^{32} disintegrations may therefore be DNA. During the decay, the yeast population becomes more and more resistant to the lethal effect of x rays. It was shown that this is not the consequence of a selective process, but the induction of radioresistance in previously sensitive cells. Clones derived from the survivors of P^{32} decay were stable as regards their resistance to x rays. After a decay which leaves ~1 out of 100 living cells, nearly all survivors yield resistant type clones. The survival curves to x rays of most of the resistant mutants are sigmoidal, with a final slope smaller by a factor of 2 to 3 than that of the sensitive strain. With alpha rays the difference in the slope is the same as with x rays, but the curves are exponential. This resistance is not affected by growing the cells in complete or in minimal mineral medium prior to irradiation. The induced resistance to x rays appears with the same efficiency whether the P^{32} decay occurs before or after irradiation of the cells. This rules out the possibility that the structure involved affects some process contemporary with the primary effect of x rays. The resistant character applies to both x and alpha rays but not UV or P^{32} decay. In addition, no additional increase in radioresistance is obtained by labeling a resistant strain with P^{32}. A radiosensitizing oxygen effect of the same magnitude was observed for both sensitive and resistant cells. The increase in radioresistance relates only the lethal action. No effect was observed on induction of mutation to prototrophy for three auxotrophic characters (His^-, Try^-, Ad^-). The resistant mutants were haploid, according to their normal DNA content and to genetic analysis involving segregation of suitable markers. Radiosensitivity (S^+) was dominant over radioresistance (S^-) for diploid cells (S^-S^+) resulting from a cross. These diploids were less resistant than the resistant haploid parent but more resistant than the haploid wild type. Their survival curve was identical to that of the diploid wild type. By the random sporulation technique of a S^-S^+ strain, it was shown that the resistant character segregates from the sensitive one with a ratio of 1:1. It was not linked to any of the three metabolic markers used in this study. The efficiency of P^{32} decay in inducing resistance to x rays corresponds to a target whose max size (assuming that it is DNA) is about $1/_{20}$ of the whole genome. It is suggested that the S^+ character is linked to a selfreproducing phosphorus-containing structure whose location and function in the cell are unknown. (BBB)

37073 THE BIOSYNTHESIS AND METABOLISM OF OESTROGENS IN THE RAT. 2. THE CONVERSION OF [4-^{14}C] TESTOSTERONE INTO [^{14}C] OESTRADIOL-17β BY THE OVARY AFTER WHOLE-BODY IRRADIATION. S. R. Stitch, R. E. Oakey, and Sheila S. Eccles (Medical Research Council, Radiobiological Research Unit, Harwell, Berks, Eng.). Biochem. J., 88: 76-80(July 1963).

The effect of whole-body irradiation (400 rads) on the ability of the rat ovary to produce estrogen in vitro from [4-C^{14}] testosterone at times up to 180 days after irradia-

tion was investigated. After an initial lag, the biosynthesis of estradiol-17β, from 6 days after irradiation onward, appeared to be as high as with tissue from the nonirradiated controls. The biosynthesis of estrogen by ovarian tissue after the destruction of follicular elements by higher doses of irradiation is discussed. (auth)

37074 CHANGES IN THE PHOSPHOLIPIDS OF MOUSE SKIN AFTER ULTRAVIOLET IRRADIATION IN VITRO. A. Tickner (Mayday Hospital, Thornton Heath, Surrey, Eng.). Biochem. J., 88: 80-4(July 1963).

When the skin of mice of strain A was irradiated in vitro with uv light, the phospholipid fraction was found to diminish and the P that disappeared from this fraction appeared as acid-soluble P or as ribonucleic acid P. The fractions of phospholipid affected were ethanolamine plasmalogen (72% destruction) and, to less extent, phosphatidylethanolamine (21% destruction). No significant changes were seen in deoxyribonucleic acid or ribonucleic acid with the methods used. (auth)

37075 INACTIVATION OF THE FRIEND VIRUS BY X AND ULTRAVIOLET RAYS. Raymond Latarjet and Liliane Chamaillard (Institut du Radium, Paris). Bull. Assoc. Franc. Etude Cancer, 49: 382-9(Oct.-Dec. 1962). (In French)

The Friend disease virus was found to be very radioresistant. This was shown by experiments in which cell-free extracts of spleens of mice bearing the virus were irradiated with 2537-Å uv and 40-kv x rays. X irradiation was carried out at a rate of 20 kr/min in the presence of air at 5°C. After irradiation the tumorigenic activity of the virus was assayed by the dilution method and inoculation into healthy mice. A 200-kr x-ray dose caused only slight inactivation of the virus, 300 kr reduced the activity to ~$1/10$ of the control value, and 800 r to <$1/100$. The uv dose required to reduce the activity of the virus to $1/10$ was ~10000 erg/mm. In some experiments, uv irradiation increased the activity of the spleen extracts, presumably by inactivating a virus inhibitor that is more radiosensitive than the virus itself. The results show that the Friend virus is two to three times more radioresistant than Rous virus, which is among the most resistant viruses. It is suggested that in Friend virus, as in other tumorigenic viruses, the tumorigenic activity resides in only a portion of the viral nucleic acid. For Friend virus it is estimated that this activity resides in a RNA fragment of less than 3500 nucleotides. The possibility that the radiosensitive virus inhibitor observed here is interferon, or a related substance, is discussed. A similar activation phenomenon was noted with the Bittner milk virus. (BBB)

37076 SKIN HEPARIN LEVELS AND POSTHEPARIN PLASMA CLEARING FACTOR LIPASE LEVELS IN IRRADIATED ADRENALECTOMIZED AND CORTISONE-TREATED RATS. Frank C. Monkhouse and Donald G. Baker (Univ. of Toronto). Can. J. Biochem. Physiol., 41: 1901-6(Sept. 1963).

Experiments were carried out to determine whether changes in endogenous heparin in rat tissues were related to changes in plasma levels of clearing factor lipase (CFL). Skin heparin levels, postheparin plasma CFL levels, and peritoneal mast cell counts were measured in normal, adrenalectomized, cortisone-treated, and x irradiated rats. Total body x irradiation in doses of 400 to 600 r decreased skin heparin levels. The postheparin CFL levels of irradiated rats remained high while that of pair-fed controls dropped significantly. Cortisone treatment for 6 days caused an increase in plasma CFL levels in both intact and adrenalectomized rats but no significant change in skin heparin levels or mast cell count. Adrenalectomy caused no significant change in either postheparin CFL or skin heparin levels. (auth)

37077 PANEL DISCUSSION ON THE CHEMOPROPHYLAXIS AND CHEMOTHERAPY OF INJURY TO IONIZING RADIATIONS. R. Koch (Universität, Freiburg i. B.). Chemotherapia, 6: 122-60(1963). (In German)

Six participants of the Second International Symposium of Chemotherapy, held in Naples in 1961, extensively discuss the effectiveness and mode of action of chemical radioprotective agents, particularly in relation to their investigations of in vitro systems, especially synthetic polymers, proteins, and nucleic acids. (BBB)

37078 PRE-NATAL IRRADIATION MUTATIONS. Marcel Devreux. Euratom Bull., No. 3, 16-20(1963). (In English)

The aim of the agricultural geneticist is to obtain new varieties of cultivated plants having interesting characteristics. Alongside the conventional methods of hybridation and crossing, there is the technique involving the induction of mutations. Irradiation is one of the ways in which the geneticist can bring about these mutations, and although good practical results have already been obtained by this method, a major effort is now being made in the field of research to secure a further improvement. The author outlines the problems involved and describes the method he has adopted in an attempt to sophisticate this technique. Primarily, the technique is concerned with avoidance of the chimera and intrasomatic selection in plant irradiation experiments through careful choice of the exact time of irradiation. It is recommended that to obtain mutations generalized throughout the plant, the plant should be irradiated either when the gametes are just distinguishable or before division of the zygote-cell. (auth)

37079 INDUCTION OF MULTIPOLAR SPINDLES BY X-RADIATION IN MAMMALIAN CELLS IN VITRO. A. G. Levis and G. Marin (Univ. of Padua). Exptl. Cell Res., 31: 448-51(Aug. 1963).

Coverslip cultures of mammalian cells in logarithmic growth were exposed to 200, 400, and 600 r x radiation and fixed at 12-hr intervals up to 108 hr after exposure. The generation time of untreated cells was about 24 hr. Mitotic figures were scored and classed according to their number of poles at different intervals after irradiation. The relative number of mitoses with a high number of poles increased steadily with time, suggesting that multipolarity was a secondary consequence of radioinduced blockage of division rather than a primary effect of x radiation on duplication of the centrioles. The shift in the relative proportion of high and low multipolar spindles was more pronounced at the highest dose, where division hindrance was more complete. (C.H.)

37080 ORAL EFFECTS OF INJECTED STRONTIUM 90. Martin A. Rushton (Guy's Hospital, London). J. Dental Res., 42: Suppl., 340-2(Jan.-Feb. 1963).

Studies were carried out on the jaws of rabbits injected with $Sr^{90}Cl_2$ in single doses, varying between 100 and 1000 μc/kg, in weanlings and animals. The rabbits were killed an hour to 9 months after injection; histological studies were done on one mandible and dosimetric studies were performed on the opposite mandible. The most severe changes in teeth and surrounding tissues were produced in weanling rabbits receiving high injected doses (>600 μc/kg). In this group, pyknotic cells were seen among differentiating odontoblasts after 24 hr (accumulated dose 150 rad) and pulp cells became separated from the internal enamel epithelium by an exudate. After 14 days (2500 rad)

depletion of pulp cells in this area was evident. At 30 days growth of the cheek-teeth had almost stopped (4500 rad) and there was fibrosis of the pulps. The recently formed parts of the teeth were of diminished diameter. The younger odontoblasts showed great disorder and the mature parts of the pulps became completely replaced by dentine. Production of enamel and growth of the enamel organ were arrested, but the enamel organs did not completely disappear. No neoplastic change was seen in any of the dental tissues with the possible exception of cementum. In rabbits injected as adults with high doses, effects occurred which were in general similar to those seen in the weanlings, but took place after a longer time or were less severe and lasting. In those injected at under 2 yr, growth and eruption of teeth were generally arrested or much retarded, as in animals injected as weanlings; but in rabbits injected at over 3 yr, continued growth and eruption of teeth were not so much retarded; so that in these, by 6 months after injection, most or all of the dentine which had contained the heaviest burden of Sr^{90} had been lost by attrition. The quality of the tooth pulps and dentine in these older rabbits also showed a high degree of recovery from damage. Pleomorphic proliferation of osteoblastic tissue was seen much later in rabbits injected as adults than in those injected as weanlings—at 6 months instead of at 2 or 3 months after injection. Dosimetry results showed that this was not due to decreased dose rates in the area concerned, for these and the calculated accumulated doses were much increased. Thus, in the weanling group, the max accumulated dose between the bases of the cheek teeth at the time that osteoblastic proliferation was evident was of the order of 9000 rad but in the adult group 47,000 rad or more. Whereas osteosarcomas were evident in four out of four rabbits of the weanlings series at 6 months after injection, they could not be recognized in the adult group at 6 months and only in one rabbit 9 months after injection. In this animal injected at 21 months of age the max accumulated dose between the bases of the mandibular cheek-teeth was ~123,000 rads, compared with the 20,000 to 50,000 rads associated with osteosarcoma of the mandible in the weanlings. The results show that, although there are in the rabbit injected as an adult preferential locations of Sr^{90} in the jaws and especially the teeth compared with the distribution in weanlings, and much higher dose rates in the jaws in all areas initially and in many areas throughout, the development of sarcoma in the jaws is slower. It is not known whether this is due to different reactivity of older tissues, higher dose rate, or other factors. (BBB)

37081 RELATIONSHIP BETWEEN TUMOR GROWTH AND RADIOSENSITIVITY. James A. Belli and J. Robert Andrews (National Cancer Inst., Bethesda, Md.). J. Natl. Cancer Inst., 31: 689-703(Sept. 1963).

To answer certain questions concerning the relation between tumor growth and radiosensitivity, survival curves for a strain-specific murine leukemia (P-388) were determined with cells irradiated in vivo, in vitro, and in situ at various times following the transplantation of 10^6 cells per recipient. It was found that the D_0 has a value of 110 r (Co^{60} γ radiation) for the survival curve of cells of 1-day growth; this value increases to about 400 r for cells 4 and 7 days post transplantation. In addition, variation of the extrapolation number was observed, which generally was inversely related to the rise in D_0. The finding of an extrapolation number for 3-day tumor cells of <1 (~0.6) suggested the presence of a population of cells of heterogeneous sensitivity. This heterogeneity was thought to be due to the presence of a few anoxic cells in a population otherwise fully oxygenated. The ratio of the reciprocal of the final slopes for the most resistant (7-day) to most sensitive (1-day) cells was 3.7. Tumor cells were also irradiated in vitro or in vivo in animals killed 15 min before exposure (referred to as irradiated in situ) at various times post transplantation. Radiosensitivity of cells irradiated in vitro or in situ appeared to be independent of growth stage. Survival-curve parameters in vitro were: n = 4.5, D_0 = 151 r; in situ n = 7.2, D_0 = 415 r. The ratio of the reciprocal of the final slopes (2.7) agrees with the O-enhancement ratios reported for other mammalian cell strains. (auth)

37082 PSEUDOMONAS AERUGINOSA INFECTION AND ITS EFFECTS ON RADIOBIOLOGICAL RESEARCH. Carolyn W. Hammond (Univ. of Illinois, Chicago). Lab. Animal Care, 13: 6-10(Feb. 1963).

Antibiotic therapy was effective in reducing postirradiation mortality of mice when P. aeruginosa was not present, but was ineffective when the test animals were infected with this organism. A method of controlling P. aeruginosa infection based on rigid sanitation is described, as are the results of studies of the mechanism by which this organism kills irradiated mice. Once this organism invaded the blood stream of an irradiated mouse, the animal died within 24 hr. P. aeruginosa epizootics were especially catastrophic during antibiotic therapy on the bacteremias of endogenous origin which occur during the second week after irradiation. Thus, when streptomycin was given from the 4th through the 27th day after irradiation, only 14% of the mice died. But when streptomycin was administered for two days after P. aeruginosa infection the epizootic proceeded rapidly, killing 100% of the controls and 97% of the antibiotic-treated mice. Polymyxin parenterally was also to no avail. In an attempt to shed some light on the mechanism by which P. aeruginosa kills irradiated mice so rapidly, mice were exposed to a midlethal dose of radiation. On the 1st, 5th, or 11th day after irradiation they were fed ~10^7 pseudomonads. When pseudomonads were fed on the first day, only 5% died of P. aeruginosa bacteremia, but when pseudomonads were fed on the 5th or 11th day, 57-60% died. Unirradiated mice fed 10^7 pseudomonads in the same manner remained healthy during the 30 day period. Bacteriologic culture of the gastrointestinal tract showed that many more irradiated mice retained pseudomonads and in greater numbers than did unirradiated mice. On the third day after inoculation, in about one-third of the irradiated mice the number of pseudomonads had actually increased, whereas in over half of the unirradiated mice they could not be detected. Apparently, large numbers of pseudomonads introduced into the stomach become established and multiply in the upper and lower intestine of irradiated mice while they tend to disappear from the intestinal tract of unirradiated mice. (BBB)

37083 DEVELOPMENT AND COURSE OF SYPHILIS IN IRRADIATED ORGANISM. P. S. Stepanov. Med. Radiol., 8: No. 7, 56-8(July 1963). (In Russian)

Experiments with 20 male rabbits weighing 1900 to 2650 g infected intrascrotally with viable Treponema (1.4 to 1.5 mil. microbes) and exposed to 600 r of radiation showed: a much shorter incubation period in irradiated and infected animals, a typical course of syphilitic infection (along with early signs of induration and serum-positive reaction, the later negative serum reaction appeared earlier in irradiated rabbits than in controls), a more prolonged induration produced a longer contagion and communicability period, and, finally, due to the weakened resistance the infected and irradiated organisms developed bacteremia that proved fatal in some cases. (R.V.J.)

37084 PROTEINEMIA IN EXTERNAL IRRADIATION OF EXPERIMENTAL ANIMALS. T. A. Glavinskaya and V. E. Pavlovskaya (Gor'kii Inst. of Medicine and Gor'kii Scientific-Research Inst. of Dermatology and Venerology, Academy of Sciences, USSR). Med. Radiol., 8: No. 7: 58-62(July 1963). (In Russian)

Studies were made of protein, protein fractions, and lipoprotein in 158 guinea pigs weighing 400 to 660 g. Beta doses from 20 to 50 r were administered using 62 cm^2 applicators containing $Na_2HP^{32}O_4$ applied to the right side of the animal. Tabulated data taken after 20-r exposures showed certain deviations expressed in a tendency to reduced albumin. Local β exposure to 50 r showed increases of 10 to 18% in total blood protein. Reduced albumin was observed in protein fractions in all exposed animals. Local external β irradiation induced biochemical changes that should be considered in therapeutic and radiation studies. (R.V.J.)

37085 THE INFLUENCE OF IONIZING RADIATION ON THE FUNCTION OF VESTIBULAR ANALYZER. A. V. Sevankaev and A. A. Sveshnikov. Med. Radiol., 8: No. 7, 82-7(July 1963). (In Russian)

Reviewed data showed that a massive local internal ear irradiation resulted in inflammatory reactions and degenerative changes in the vestibulary nerve structures. Whole-body exposure to small doses of radiation resulted in increased excitability of the vestibulary apparatus. (R.V.J.)

37086 REVERSAL OF GAMMA-RAY-INDUCED SUSCEPTIBILITY TO DECAY OF POTATO TUBERS AND TOMATO FRUIT BY METHYL ESTER OF INDOLYL-3-ACETIC ACID. P. B. Mathur (Atomic Energy Establishment, Trombay, India). Nature, 199: 1007-8(Sept. 7, 1963).

Treatment with the methyl ester of 3-indoleacetic acid reduced considerably the high initial decay rate in potato tubers and tomatoes treated with γ radiation to preserve the storage life. (C.H.)

37087 NUCLEAR FACTORS INVOLVED IN THE RADIATION-INDUCED DEPRESSION OF DNA SYNTHESIS OF DEOXYRIBONUCLEIC ACID. Shirley M. Lehnert and S. Okada (Univ. of Rochester, N. Y.). Nature, 199: 1108-9(Sept. 14, 1963).

Studies of the effect of whole-body irradiation on the ability of liver cell nuclei to synthesize tritiated thymidine when assayed in a DNA-synthesizing system were made in rats. In order to determine the site of radiation damage in the nucleus, experiments were carried out using nucleoprotein fractions and DNA extracted from nuclei as a source of primer DNA. Results are given from various preparations of liver 24 hr after irradiation and 48 hr after partial hepatectomy. In all cases incorporation into the control preparation exceeded that into the irradiated preparation. The fact that the radioinduced reduction in the ability of DNA to incorporate tritiated thymidine disappears when the DNA is freed of residual protein strongly suggests that the x-ray induced lesion that produces this effect resides in the nucleoprotein complex. (H.M.G.)

37088 STUDIES ON THE GENETIC MULTIPLICITY OF A GENE IN YEAST CELLS. I. CHARACTERISTICS OF THE INDUCED MUTATIONS BY SUBCRITICAL TEMPERATURE AND ULTRAVIOLET LIGHT. Takashi Ito, T. Yamasaki, and Y. Matsudaira (St. Paul's (Rikkyo) Univ., Tokyo). Nippon Idengaku Zasshi, 37: 276-83(Aug. 1962). (In English)

By using subcritical temperature and ultraviolet light as DNA-attacking agents, the duplex nature of ad locus gene mutation in yeast cells was studied at the molecular level. The relative frequencies of whole-colony mutation and fractional-colony (sectored) mutation induced by these two agents are strikingly different: 59% whole, 23% fractional and 18% undefined for subcritical temperature; 14% whole, 72% fractional and 13% undefined for ultraviolet light. The results are interpreted to indicate a genetic multiplicity of two of the genes, based on the assumption that subcritical temperature causes changes by a single event in both strands of a gene-DNA molecule and ultraviolet in one of the two strands. (H.M.G.)

37089 X-RAY INDUCED CHROMOSOMAL ABERRATIONS IN RICE PLANTS. Taira Katayama (Kyushu Univ., Fukuoka, Japan). Nippon Idengaku Zasshi, 38: 21-31 (Feb. 1963). (In English)

Dry and soaked seeds of several varieties of rice plants were given various x-ray doses at 120 kvp, 3 ma, distance 26 cm, no filter. Results of cytogenetical observation of plants in which chromosomal aberrations resulted in sterility are briefly summarized. About 68 per cent of the chromosomal aberrations observed was the interchange heterozygote including ④ and ④+④, and about 32 per cent were trisomics, asynapsis, syncyte formation and polyploidy. The interchange heterozygotes were divided into several types based on the frequencies of ring or chain formation of four chromosomes at diakinesis. Fertility (seed or pollen) in the interchange heterozygote ran approximately parallel to the frequency of side-by-side configuration of the interchange complex at metaphase-I. Fertility in the progeny of the selfed interchange heterozygote differed from plant to plant, that is, some plants divided into two fertility groups, high and low, and other ones showed continuous deviations. In the progeny of the selfed interchange heterozygote, plants with RT (interchange heterozygote) and without RT (non-interchange heterozygote) showed the segregation of 1:1 ratio. In the same interchange heterozygote, there was such a case showing much difference in distribution of fertility and segregation of the interchange heterozygote. Asynapsis and syncyte formation were observed, the latter being the first example in rice plants. Polyploidies, such as haploidy, triploidy and tetraploidy, were also isolated from the progeny of x-ray irradiated rice plants. (auth)

37090 STUDIES ON THE EFFECTS OF RADIATION ON PHOSPHORUS METABOLISM OF THE MOUSE STRAIN L CELLS IN CELL CULTURE. Masakatsu Horikawa, Tsutomu Sugahara, and Yukio Doida (Kyoto Univ.). Nippon Idengaku Zasshi, 38: 32-5(Feb. 1963). (In English)

The effect of γ-irradiation on the phosphorus (acid soluble fractions) metabolism of mouse strain L cells in culture was studied in an attempt to shed light on the mechanisms of radiation inhibition of cell multiplication. Content and incorporation of P^{32} into the acid-soluble fractions of the cells were measured following a Co^{60} gamma dose of 2000 r, the dose known to yield 50% inhibition of cell multiplication. Phosphorus-32 incorporated into each compound was measured with a Geiger-Muller counter, and the phosphorus content of each compound was derived by the method of Horecker slightly modified. Significant decrease in P^{32} incorporation was noted in the fractions containing CMP (calcium metaphosphate), DPN (diphosphopyridine nucleotide), and adenine compounds such as ATP (adenosine triphosphate), ADP (adenosine monophosphate), and AMP (adenosine monophosphate). However, no significant phosphorus decrease was observed in ATP, ADP, or AMP. An increase in P^{32} incorporation was noted in the inorganic phosphate fraction. It is concluded that the processes of

oxidative phosphorylation with its concurrent formation of high energy phosphorus compound have been primarily damaged by γ-irradiation. The correlation observed between the inhibition of cell division and the reduction in the formation of high energy phosphorus compounds may provide a clue for resolution of the nature of cell division and the effects of radiation on it. (H.M.G.)

37091 RADIOBIOLOGICAL STUDIES IN PLANTS. VIII. RADIOSENSITIVITY OF PLANTS CULTURED UNDER PHOSPHORUS DEFICIENT CONDITIONS. Ichizo Nishiyama and Etsuo Amano (Kyoto Univ.). Nippon Idengaku Zasshi, 38: 61-8(Feb. 1963). (In English)

Diploid oats of an early mutant strain were grown for some generations in granite sand supplied with Kasai's nutrient solution or with that lacking phosphate. The latter showed typical symptoms of P-deficiency, that is, inhibition of plant growth. However, no evident effect of P-deficiency was found that was attributable to chromosomal abnormalities or gene mutations. When young panicles of these P-deficient plants were irradiated with 250 r of x rays, the panicles in the full growth were apparently shorter than those of the plants which were not irradiated. Also a slight increase in the frequency of chromosome aberrations in the pollen mother cells of P-deficient plants was observed. Dry seeds obtained from P-deficient plants were irradiated with 10–70 kr of x rays. No seeds having a dose of 40 kr or more germinated. In 16 day old seedlings, P-deficient ones showed a higher radiosensitivity than the controls at the dose of 30 kr, as indicated by the reduced survival rate and plant height in the former. A slight increase in mutation rate was found in the X_2 progenies of P-deficient plants though it was not statistically significant. (auth)

37092 ON THE EMBRYOPATHY FROM IONIZING RADIATIONS. Vincenzo Buffa (Università, Naples). Pediatria (Naples), 70: 313-19(Mar.-Apr. 1962). (In Italian)

Experimental and clinical reports of fetal defects resulting from irradiation in utero are reviewed and the hazards of radiodiagnostic procedures in pregnant women are discussed. (BBB)

37093 INFLUENCE OF X-IRRADIATION ON UV-FLUORESCENCE OF ISOLATED NUCLEI AND MITOCHONDRIA. G. M. Barenboim, R. I. Pinto, and K. I. Pravdina. Radiobiologiya, 3: 8-12(1963). (In Russian)

Fluorescence of cells as a sensitive criterion of lesion in early radiation injuries is investigated. In some cases, a change of the intensity or spectrum of the fluorescence can be detected in the irradiated cells earlier than any cytochemical or morphological change. Thus, application of the technique of fluorescence to the detection of radiation injury in isolated nuclei and mitochondria was studied in liver and spleen cells of the rat. After fractionation of a cellular homogenate, nuclei suspended in sucrose, and the fluorescence was measured. Intensity of luminescence of unirradiated spleen nuclei was 1.60 ± 0.20 times that of unirradiated liver nuclei. Nuclei were then x-irradiated at a dosage rate of 1820 r/min for 5, 20, and 40 minutes, and their fluorescence was measured at intervals from 10 to 20 minutes afterward. Significant differences in fluorescence intensities of irradiated and unirradiated nuclei were not detected. Previous work indicating attenuation of fluorescence during ultraviolet irradiation was confirmed for liver and spleen nuclei. For the nuclei previously damaged by ionizing radiation the value of the ultraviolet attenuation factor was found to be higher than in the case of undamaged nuclei. Luminescence intensities were measured in mitochondria also. Mitochondria damaged by a previous x-irradiation were found to attenuate more rapidly than the undamaged ones. It was concluded that: nuclei of cells from both liver and spleen and mitochondria from the spleen display ultraviolet fluorescence; intensity of fluorescence of nuclei and mitochondria decreases under the effect of ultraviolet radiation; fluorescence of nuclei and mitochondria exposed to a previous x-irradiation is damped by the effect of ultraviolet light more rapidly than that in nuclei of cells from the liver; and the technique described is capable of detecting radiation lesions in mitochondria at lower doses than the majority of biochemical methods. (H.M.G.)

37094 ON THE ROLE OF REACTIONS BETWEEN FREE CYSTEINE AND PEROXIDES IN BIOLOGICAL EFFECTS OF IONIZING RADIATIONS. V. N. Benevolenskii. Radiobiologiya, 3: 13-16(1963). (In Russian)

Due to the assumption that sulfhydryl compounds exert prophylactic action during irradiation by neutralizing the primarily arising radicals or by way of the creation of hypoxia, thus reducing the yield of secondary radicals and peroxides; the biological significance of reactions between sulfhydryl compounds and peroxides being formed is of particular significance. A study was made of the effect of hydrogen peroxide and urea peroxide on irradiated and unirradiated cells of Saccharomyces vini, Megri-139-B strain, acted upon simultaneously by free cysteine. Suspensions of yeast cells were supplemented with cysteine, or one of the peroxides, or both simultaneously. After 15-20 min the cells were irradiated with Co^{60} gamma rays at doses of 30 and 50 kr, at a dose rate of 400 r/min. Samples were thin cultured on plates for 4-5 days at 30°. The percentage of cells in which division was inactivated by the radiation was determined in relation to the unirradiated control to which no substances were added by colony count. It was found that free cysteine added in the amount of 10^{-3}M and more to the suspension of irradiated and unirradiated yeast cells treated with hydrogen peroxide and urea peroxide intensifies the effect of inhibition of cell division by peroxides. It is suggested that this possibly occurs at the expense of chemically reactive radicals formed upon reaction of peroxides and cysteine. Peroxides alone intensify radiation injury only in the presence of toxic or subtoxic concentrations. Peroxides added in nontoxic concentrations before irradiation apparently exert a weak protective action on the inactivation of cellular division of yeast and intensifies the antiradiation action of cysteine. (H.M.G.)

37095 TYROSINASE ACTIVITY OF SKIN IN IRRADIATED MICE AND RATS. E. A. Ivanitskaya and A. M. Kuzin. Radiobiologiya, 3: 17-20(1963). (In Russian)

Studies were made to determine whether the activation of the enzymic system that transforms tyrosine into biologically active orthoquinones is characteristic of animal tissue. White male rats and mice were given a whole-body dose of 1000 r Co^{60} gamma radiation. At various intervals postirradiation (2, 4, 6, and 24 hours), the animals were decapitated; and the skin was removed. A homogenate of the skin was prepared in phosphate buffer and tyrosine solution and incubated at 37°. Tyrosinase activity was determined from the amount of orthoquinones formed. Results indicate that whole-body irradiation of rats and mice with a lethal dose leads to the activation of tyrosine in the skin during the first hours after irradiation. Maximum activation of skin tyrosinase in mice and rats was observed within 3 to 4 hours postirradiation followed by a slow fall during the first 24 hours. Due to the activation

of tyrosinase, an increase of biologically active orthoquinones occurs in the skin of irradiated animals during the first hours after exposure. It is suggested that the resulting substances may be products of the adrenal system along with free tyrosine. (H.M.G.)

37096 INFLUENCE OF WHOLE-BODY X-IRRADIATION ON ASCORBIC ACID CONTENT IN SOME ORGANS AND PERIPHERAL BLOOD OF RATS AND GUINEA PIGS. S. T. Riskulova. Radiobiologiya, 3: 24-8(1963). (In Russian)

The effects of radiation on the ascorbic acid (AA) content in various organs and in the blood of animals synthesizing AA (rats) are compared with effects in animals not synthesizing AA (guinea pigs). For 12 to 14 days prior to, and during the experiment, young male rats and guinea pigs were maintained on scorbutogenic rations. Guinea pigs were additionally given 15 mg of AA daily (elevated dose) each and 2 mg (minimal dose to prevent scurvy). Acute radiation sickness was induced in the animals by a single whole-body 700 r dose of x rays. The concentration of AA in liver, spleen, adrenals, and blood plasma was determined one hr, 24 hrs, 3 days, and 7 days postirradiation. Results of experiments were processed using variational statistics and expressed in percents. As a result of x irradiation, it was found that changes of the AA content occur in a number of vitally important organs and in blood plasma of rats and guinea pigs. The character of these changes is different in animals that synthesize AA and in those that do not, the sharpest differences being found during the first minutes after irradiation in the tissue of the brain and liver. Significant differences in the AA content of various organs in the two species may be explained by the difference in reaction of those organs to the irradiation. Literature on the effects of 550–1000 r radiation doses on AA content in animals is reviewed. (H.M.G.)

37097 DEHYDRASE ACTIVITY OF TISSUES AFTER THE TREATMENT WITH LOW TEMPERATURE AND IONIZING RADIATIONS. Yu. K. Ledentsov. Radiobiologiya, 3: 29-33(1963). (In Russian)

White rats were used to study the activity of certain dehydrogenases in various tissues during local hypothermia and whole-body x irradiation. A condition of hypothermia was accomplished by application, to hind extremities of the animals, of a rubber bladder filled with a refrigerating mixture for 90 minutes. Within 24 hrs, the action of hypothermia resulted in 2nd to 3rd degree frostbite of the hind legs. Hypothermia of the skin followed. The animals were given a 700 r whole-body dose of x radiation. Activity of glutamicodehydrogenase, lacticodehydrogenase, and succinic dehydrogenase was determined in the liver, muscles, and brain of both groups. Those animals subjected to cold stress were decapitated immediately after hypothermia, whereas x-irradiated animals were investigated on the 7th day postirradiation. In a further experiment hypothermia was induced in x-irradiated animals. In the group subjected to local cold stress there was a marked increase of dehydrogenase activity of the liver, a noticeable increase in lacticodehydrogenase activity in the brain, and no detectable change in muscle dehydrogenases. Animals with pronounced manifestations of radiation sickness showed a significant decrease in glutamicodehydrogenase activity in the liver as well as a tendency toward decrease of succinic dehydrogenase activity in all investigated organs. In irradiated animals subjected to hypothermia, a noticeable decrease in dehydrogenase activity was observed. Data are discussed in terms of compensatory biochemical manifestations of the thermal regulatory mechanism. (H.M.G.)

37098 RECOVERY OF VIABILITY OF α-IRRADIATED YEAST CELLS OF DIFFERENT PLOIDY. V. I. Korogodin, V. Bilushi, L. I. Markova, and Ya. L. Skekhtman. Radiobiologiya, 3: 39-44(1963). (In Russian)

Studies were made of the capacity for endless reproduction of yeast cells of different ploidy irradiated with α particles. The restoration effect was detected in all strains possessing two or more chromosomal sets. It was shown that although α particles exert, as a rule, stronger damaging action than x or γ rays, the capacity of cells for restoration at a given degree of injury does not depend on the form of radiation that had produced the injury. (auth)

37099 INFLUENCE OF UV- AND IONIZING RADIATIONS ON BONE MARROW HEMOPOIESIS IN GUINEA PIGS. T. A. Sviderskaya and I. N. Filipson. Radiobiologiya, 3: 45-52(1963). (In Russian)

Intravital investigations were carried out on the bone marrow in guinea pigs at remote periods (8-10 months) after γ irradiation and within 10-40 days after x irradiation. It was found that in animals, which were exposed to a previous action of UV-rays, the medullary hemopoiesis after γ irradiation is more intensive, as compared with the control (γ irradiation only). The difference in hemopoiesis is expressed in a higher content in myelograms, of cells of erythroid series, and in a higher amount of myelokaryocytes in punctates of the bone marrow in experimental animals. Upon investigation of the bone marrow at earlier intervals after radiation injury (40th day) the difference in hemopoiesis is between the group of animals exposed to UV irradiation and subsequent x irradiation, and the group of animals subjected only to x irradiation is even more marked. Investigation of the bone marrow in guinea pigs following a course of UV-irradiation showed a considerable increase in the punctates of the bone marrow, of cells of the erythroid bud and of reticulocytes as compared with the original data. The investigations performed point to a stimulating effect of UV rays upon medullary hemopoiesis. (auth)

37100 GYNOGENESIS IN STURGEON FISH OBTAINED BY MEANS OF IRRADIATION. D. D. Romashov, N. I. Nikolyukin, V. N. Belyaeva, and N. A. Timofeeva. Radiobiologiya, 3: 104-10(1963). (In Russian)

In the present preliminary work the possibility has been shown of producing diploid gynogenesis in the sturgeon, sterlet and beluga. It has also been shown that in hybrid crossings after irradiation of sperm with a high dose (100 kr) the progeny copies entirely the characters of the maternal species. At the same time, the diploid (apparently normal) gynogenetic larvae obtained are distinguished by their low viability. According to this material, the viability in experiments on gynogenesis is reduced in other species of fish also (loach, carp), but not so markedly as in sturgeons. In the loach, for example, in the case of gynogenesis (when the sperm are irradiated with a dose of 100 kr) the mortality of the developing roe amounts to a total of 8-20 percent; in the carp, 32-50 percent, whereas in sturgeons it is 85-95 percent. Thereby, the apparently normal larvae which hatch out in the experiments with the loach and carp (gynogenetic diploids) are apparently more viable; in the carp, for example, it is possible to bring their cultivation to the age of two years (1+), three years (2+) and probably even older. The question arises, what are the causes of such a reduction of the viability of gynogenetic diploids? First of all, in using the method of deactivating the nucleus of the sperm cell by irradiation it was seen cytologically that the head of the sperm cell, as in normal development, is converted into a male pronucleus and only then, in metaphase, does it form a pyknotic body which

occupies a central position in the spindle of the first cleavage division. Such a position of the sperm cell nucleus can introduce mechanical interference into the division of female chromosomes, without mentioning the fact that the presence of a pyknotic nucleus can create different biochemical conditions in the cytoplasm, distorting the normal course of segmentation and further development. The fact that the presence of the deactivated nucleus is not immaterial for the developing embryo, is evidenced by the somewhat increased percentage of anaphases and telophases with chromosome bridges in the cells of the caudal epithelium of one-day larvae in the irradiation experiments compared with the controls. Thus, in the controls the percentage of cells with bridges in the sterlet amounts to M_k = 2.00 percent ±0.50; for larvae from the irradiation experiments, M_{100kr} = 9.47 percent ±0.78 (Diff ± m_{diff} = 7.47 percent ±0.92); approximately the same relations are observed in the sturgeon larvae, M_k = 2.79 ± 0.38, M_{100kr} = 8.50 percent ±1.48 (Diff ± m_{diff} = 5.71 percent ±1.52). Similar data were obtained for the loach and the carp, where embryonic mitoses were recorded at the gastrula stage. Other causes for the reduction in the viability of the diploid gynogenetic individuals are identified. (auth)

37101 MEDICAL PROBLEMS RESULTING FROM THE USE OF ATOMIC ENERGY. L. Carlbom, L. Engstedt, K. G. Luning, A. Norden, and A. Swensson (Karolinska Sjukhuset and Univ. of Stockholm). Svenska Lakartidn., 58: 2543-74(Sept. 15, 1961). (In Swedish)

Injurious effects of radiation on biological systems are reviewed. (BBB)

37102 MEDICAL PROBLEMS RESULTING FROM THE USE OF ATOMIC ENERGY. L. Carlbom, L. Engstedt, K. G. Luning, A. Norden, and A. Swensson (Karolinska Sjukhuset and Univ. of Stockholm). Svenska Lakartidn., 58: 2631-61(Sept. 22, 1961). (In Swedish)

37103 MEDICAL AND BIOLOGICAL EFFECTS OF PHYSICAL VIBRATIONS AND RADIATIONS. 8. ASPECTS OF THE PRACTICAL CONSEQUENCES OF MEDICAL AND BIOLOGICAL EFFECTS OF PHYSICAL VIBRATIONS AND RADIATIONS. Per Hedenius. Svenska Lakartidn., 59: 949-51(Mar. 22, 1962). (In Swedish)

37104 A STUDY OF THE MECHANISM OF INACTIVATION OF ANTI-HAPTEN ANTIBODY BY COBALT-60 GAMMA RADIATION. Shanti Kumari Seth. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 168p.

Results are reported from a study of the mechanisms of radioinduced antibody inactivation. Results reported for Co^{60} γ radiation in the dose range of 0 to 30×10^4 rep at 0 or 26°C using ethanol-fractionated gamma globulin or purified antibody, prepared from rabbit antisera against the p-azobenzoate or trimethyl-ammonium determinant groups. Antibody combining activity was measured by equilibrium dialysis on the basis of binding or homologous radioactive hapten. The feasibility of "all or none" inactivation was also studied by irradiation of antibody in the presence of homologous hapten. Experimentally determined relations between radiation dose and inactivation indicated that multiple free radical reactions are associated with inactivation. A progressive increase in gross molecular disorganization with dose was indicated by a change in reduced kinematic viscosity, and some degree of molecular rearrangement was suggested by disulfide analysis. After irradiation at 15×10^4 rep, the average number of combining sites per antibody molecule dropped from 2.1 to 0.7. (C.H.)

37105 THE EFFECTS OF GAMMA-IRRADIATION ON ASCORBIC ACID CONTENT IN RAPHANUS SATIVUS L., THE RADISH, AND ITS RESULTANT EFFECT ON THE MORPHOLOGY AND GROWTH OF THE PLANT. Gerald A. Myers. Thesis, Brookings, S. Dak., South Dakota State Coll., 1963. 121p.

Results are reported from studies on the effects of γ radiation on ascorbic acid content in the radish, Raphanus sativus L., and resultant effects on the morphology and growth of radish plants. (C.H.)

37106 VII RASSEGNA INTERNAZIONALE ELETTRONICA E NUCLEARE. V CONGRESSO NUCLEARE 1960. VOLUME TERZO. SIMPOSIO DI RADIOBIOLOGIA MEDICA, ROMA, 25-26 GIUGNO 1960. IL PRESENTE SIMPOSIO COSTITUISCE IL IV CONGRESSO DELLA ASSOCIAZIONE ITALIANA DI RADIOBIOLOGIA MEDICA. (VII International Electronic and Nuclear Review. V Nuclear Congress. Volume 3. Symposium of Medical Radiobiology, Rome, June 25-26, 1960. This Symposium Represents the 4th Congress of the Italian Association of Medical Radiobiology). F. Fossati and L. Forti, eds. Rome, Rassegna Internazionale Elettronica Nucleare e Teleradiocinematografica, [1960]. 746p.

Thirty-one papers are included; separate abstracts have been prepared for each. (H.M.G.)

37107 METHODS AND PROBLEMS IN THE ANALYSIS OF BIOLOGICAL EFFECTS OF RADIATION IN MAN. L. L. Cavalli Sforza (Università, Parma, Italy and CNRN, Italy). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 31-56. (In Italian and English)

Ionizing radiation has at least two types of irreversible effects on irradiated cells: it may kill them, and it may alter them permanently. An alteration induced in a cell which is transmissible to its descendants, is called genetic. It is fairly safe to assume that most, if not all, of the immediate effects of radiation are the result of cell killing (direct or indirect), while many of the delayed effects of radiation are the result of genetic damage to cells. The damage will show up in the irradiated individual if the altered cells belong to the somatic line; in his descendants if the cells are germinal ones. The former category of delayed effects is the one for which more quantitative data are available, especially concerning leukemia. For other effects such as cancer, malformations etc. the evidence also shows the importance of radiation in inducing the effects, although quantitative data are rare or missing. In leukemia, the effect per roentgen absorbed can be given with a relatively small error, on the assumption of a linear dependence of effect with dose. The assumption of linearity has some implications which have been shortly reviewed along with the present evidence, and the difficulties connected with its analysis. Delayed effects which show in the progeny, immediate or remote, are still less well known. Here it is fairly safe to assume, from experimental data in other organisms, that linearity holds, but the effect per roentgen absorbed has been estimated only with a very large error. A method which may give information on this point is shortly outlined. As the diagnostic and therapeutic use of radiation is already large and likely to increase, more precise estimations than those available and greater precautions than are common today are urgently needed. Ways to achieve this aim, and some practical implications were briefly discussed. (auth)

37108 PHYSICAL QUANTITIES OF IMPORTANCE IN RADIOBIOLOGY. H. H. Rossi (Columbia Univ., New York). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 57-66. (In English)

The precise numerical assessment of physical characteristics of the interaction between ionizing radiation and bio-

logical systems has hitherto been mainly restricted to the measurement of absorbed dose, i.e., the energy absorbed per unit mass in irradiated tissues. A great deal of ingenuity and effort has been expended in the measurement of absorbed dose, and while a number of major problems must still be solved, most difficulties incident to the measurement of absorbed dose have been overcome. Absorbed dose commonly encountered in radiobiological experiments represents a very small average energy absorbed in large tissue masses; however this energy originates in and diffuses from minute sites of high initial concentration. An understanding of the action of radiation on biological systems requires a knowledge of the initial distribution of energy in or in the vicinity of such subcellular structures as chromosomes, membranes, and macromolecules. Physical quantities that characterize such distributions are difficult to formulate and methods for their measurement are not easily available since work along these lines has begun only recently. Results obtained to date are surveyed and their implication to radiobiological research are discussed. (auth)

37109 RADIATIONS OF DIFFERENT ENERGIES AND THEIR APPARENT ELECTIVE AND ANTAGONISTIC BIOLOGICAL ACTIONS. G. G. Palmieri and A. Corinaldesi (Universita, Bologna). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 67-83 (In Italian and English)

From clinical observations and theoretical considerations a working hypothesis is set forth, on which basis a series of experiments on man was begun. Clinically, the results obtained show that patients irradiated with conventional tension (200 kv) up to the limit of skin tolerance, may immediately be submitted to further irradiations with radiations of about 2 Mev energy, without encountering damage, even showing a regression of the previous skin reaction, thus giving rise to the outward appearance of an antagonistic action between the two types of irradiation. On the other hand, irradiation with high total doses (5000-6000 r at the integument level) by means of high energies, may cause, particularly in the hypogastrium and buttocks of obese patients, integument atrophies and pachydermias with no previous primary reactions of particular intensity, as when employing high doses of 200 kev radiations, so that we also have the outward appearance of an elective biological action from radiations of different energies. Theoretically the possibility exists that such phenomena may be due, rather than to peculiarities of the true biological action, to conditions of physical order, that is, the different build-up in connection with the two different types of radiations employed: the 200 kev one causing the maximum dose at the level of the dermic papillae, the 2 mev in the subcutaneous tissue. On this basis the hypothesis was submitted that irradiation on consecutive days (6 days a week) alternating the two types of radiation on different days might improve the tolerance conditions of the integument. Of course the total depth dose will consequently be the average between those permitted respectively by irradiation with 200 kev alone and 2 Mev. The data resulting from the observations on the patients thus treated, seem to uphold such a hypothesis. Interpretation also appears to be viewed in the light of such a hypothesis, viz., in the sense of a different distribution of energy in the first layers, rather than in the sense of an elective and antagonistic biological action from radiations of different energies. The biological action, however, might work in the sense of a recovery (reinstauration), even if not complete, in the different layers, connected to the alternate rythm of the irradiation. Preliminary results seem to allow a useful application of this method in radiotherapy. (auth)

37110 BIOLOGICAL PROTECTION AGAINST IONIZING RADIATION. H. Langendorff (Universität, Freiburg i. B.). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 85-99. (In Italian and English)

A general report of the present investigations on biochemical radiation protection is given. At the same time present theories of the mechanisms of radiation effects in biological material are reported. (auth)

37111 BIOLOGICAL METHODS OF APPRECIATION OF THE DOSE RECEIVED THROUGH EXTERNAL IRRADIATION. D. Mechali (CEA, Gif sur Yvette, France). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 105-22. (In Italian and English)

The way of treating the subjects exposed to acute external irradiation varies according to the dose received. Estimations reached by physical dosimetry must be confirmed by the observation of patients. Some biological investigations may bring a useful contribution to the appreciation of the dose which has been actually sustained. The comparison of 24 cases of accidental external irradiation sets off a correlation between the dose and the number of certain elements in peripheral blood, in particular the number of lymphocytes from the 3rd to the 5th day, and that of leukocytes around the 10th day. Such correlations must be interpreted with great caution. The study of some cytological alterations of blood elements, and more particularly the frequency of binucleate lymphocytes, as well as the mitotic index of bone marrow, can supply appreciation elements. As regards animals, there is a rather close relation between the dose received and the erythropoietic activity, as appreciated by the incorporation of radioactive iron in erythrocytes. Similar observations could be usefully carried out on man upon the occasion of total irradiations practiced with a therapeutic purpose. Urinary excretion of β-aminoisobutyric acid, reflecting DNA metabolism, seems to be in correlation with the received dose. Lastly, the appreciation in blood, urine, or in the whole body, of sodium-24 produced under the action of neutrons, is a positive basis for the evaluation of neutron dose received. (auth)

37112 THE GENETICALLY SIGNIFICANT RADIATION RECEIVED FROM DIAGNOSTIC RADIOLOGY. S. B. Osborn (University Coll. Hospital, London). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 125-40. (In English)

Methods of calculation of genetically significant radiation are discussed, and the various estimates of the dose from diagnostic radiology are compared. The main problem in any assessment is the determination of the average gonad dose for each sex and for each type of examination; methods of measurement are discussed and illustrations are given of the variability of the results obtained. An outline is given of the British Adrian Committee survey, now nearing completion, and a description of the methods and equipment used. This survey underlines the need for making measurements in a wide selection of hospitals, and indicates the ways in which the available man-power can be used to best advantage. Some general conclusions are drawn about the genetic hazard associated with diagnostic radiology. (auth)

37113 RADIOEPIDEMIOLOGY—A SEARCH FOR HUMAN STUDY MATERIAL. C. W. Shilling (Atomic Energy Commission, Washington, D. C.). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 143-65. (In English)

Since the use of human beings in research likely to be deleterious is prohibited, biomedical experiments must be carried out on various types of animals. It is interesting to note that in a recent census taken in USAEC laboratories, 319,535 fish, fowl, and mammals of 25 different kinds were used. Yet in spite of the very best type of animal experimentation, there still remains the problem of translating results obtained in animals to the human, and frequently this is a big step. However, in searching for cases of human exposure to radiation, it was found that a great many radiation experiments have already been accomplished either by nature, industrial activity, medical practice, accidents or incidents of war. The use of radiation in medical practice furnished the largest number of subjects for study—x-ray irradiation on the thymus in young children; x-ray pelvimetry in the first trimester of pregnancy; radium salts injected intravenously for mental disease; radium salts injected intravenously for arthritis; use of thorotrast. Industry added the radium dial painters; surveillance fluoroscopy of employees; and accidents involving exposure to radiation. Accidents in testing nuclear weapons resulted in exposure of Japanese fishermen and the natives of Rongelap Atoll. Dropping atomic bombs on Hiroshima and Nagasaki exposed many Japanese. From analysis of human exposure to radiation and from the experimental animal work, it was found that the effects of ionizing radiation may vary from no measurable signs or symptoms, through acute symptoms which may eventuate in death. There also may be chronic sequelae, and there is ample evidence that radiation is a mutagenic agent. More information on the effects of radiation on human populations is needed. There must be many other experiments in other parts of the world that are available for the scientist to study. The monazite sands in India, the Yugoslav reactor accident, the radiation treatment of ankylosing spondylitis in England are examples of studies either completed or contemplated. Instigation of a human radiation exposure year is suggested. (auth)

37114 INFLUENCE OF OXYGEN UPON BIOLOGIC RADIOSENSITIVITY. M. Lupo, G. Pisani, and U. Colombo (Ospedale Maggiore, Novara, Italy). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 167-208. (In Italian and English)

Data on volumetric variations, cytohistological and cytohistochemical modifications of Walker's tumor grafts in 84 mice under different irradiation conditions with varying pressures of oxygen are reported. Volumetrically it was observed that: the tumors of 450-500 mm^3 irradiated with 1000 rads with pO_2 = 1 atm. show regressions that are higher than the controls irradiated in air (pO_2 = 150 mm Hg); the tumors of 1250-1300 mm^3 irradiated with the same technique, show regressions that are higher by 40% with respect to the controls, and by 55-60% if irradiated with 2000 rads; with the irradiation at 1000 rads under an oxygen pressure of 2 atm, the tumors of 450-500 mm^3 do not show any difference of reaction with respect to those irradiated under a tension of 1 atm.; the tumors of 1250-1300 mm^3, show a further regression of about 15% and, when irradiated with 2000 rads, an increase of 10%. The cytohistological and histochemical findings are in agreement with the volumetric ones. From a combined cytological and angioarchitectural study it results that, following irradiation, the regressive processes are particularly stressed in a halo around the capillary vessels. Furthermore the mechanism of the oxygen effect is discussed, considering first the hypotheses suggested by different investigators, each explaining only partially the available experimental data. In conclusion validity is assumed of the diffusion model, conveniently interpreted, on the basis of the recent findings of radiochemistry and macromolecular chemistry. The particular behavior of oxygen is attributed to its structure of radical molecule, which allows interactions with all the chemical and physico-chemical entities (radicals H, OH, HO_2; H_2O_2, peroxides and organic ions, excited organic molecules, etc.), playing a role in the interactions between biological materials and radiation. (auth)

37115 INFLUENCE OF TENSIOACTIVE BATHOTONIC SUBSTANCES ON THE BIOLOGIC ACTION OF RADIATIONS. L. Oliva (Universitá, Genoa). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 209-25. (In Italian and English)

In a series of experimental research studies it was ascertained that when irradiation is preceded or followed by the application of a tensioactive bathotonic substance there is an increase in the radiobiologic action. Particularly, it was observed that cutaneous erythema occurs more rapidly and with greater intensity when the radiant action is preceded or followed by the application of a bathotonic, tensioactive substance (tween 40). In potato tubers the formation of pigmented compounds subsequent to the phenolasic action of their substrates, takes place earlier and with greater intensity in the segments undergoing radiant action after the application of a tensioactive substance, or upon which these substances have reacted after the irradiation. Finally, the phenomenon of hemolysis in sodium chloride solutions, less concentrated than a physiological solution, can be obtained more rapidly and with greater intensity, when to the bathotonic, tensioactive substances the action of radiations are associated in doses which normally are not capable of hemolysis determination. It is believed that there exists an interrelation between the action of radiation and the action of tensioactive substances, that is to say that it is possible to arrive at the summation of homologous actions which would disturb, more deeply than mere irradiation, the general physico-chemical equilibrium of the cytologic structures, particularly those of the cytoperipheral ones. The alteration of the homoestasis in submicroscopic structures, having limiting characteristics of the asymmetrical type from the physico-chemical point of view, favors the transferring into determinate structures of substances which normally are actually hindered by the heterogeneity of their constitution. The decrease of the surface tension can increase the structural and functional disorder determined in the cells by irradiation. (auth)

37116 A COMPARISON BETWEEN EXPERIMENTAL DATA AND CLINICAL OBSERVATIONS IN THE EVALUATION OF RADIATION EFFECTS. C. Biagini (Universitá, Rome and CNRN, Italy). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 230-62. (In Italian and English)

Some of the most peculiar aspects of the effects of various types of radiation, observed in some experiments on mammals, are compared with the results of medical applications. For the so-called high energy radiations, clinical and experimental material of the Institute of Radiology in the University of Rome was used. For the comparison with neutrons, reference is made to the data available in the literature. Modifications induced by radiation on normal tissues of experimental animals are discussed; modifications observed on experimental tumors are described and therapy of human tumors is considered. The effects on normal tissues are analyzed from the standpoint of the total dose, of the time-effect curves, and in connection with the chronological distribution of the dose. Differences

existing in the different types of radiation show a tendency to decrease with the increase of the total dose. The time-effect curves show, on the contrary, that in many cases such differences are more marked when repair processes occur. While generally the RBE is increasing with the increasing of the mean values of the linear energy transfer of the radiation, the kinetics of the experiments and the influence of the time factor indicate that the repair potentiality of the produced injuries shows a tendency toward a decrease with an increasing LET. The comparison between the results of the experiments and the data observed on human, non-neoplastic tissues during radiotherapeutic treatments, satisfactorily agrees with the exposed concepts, as far as the quantitative trends of the phenomena are concerned. From the analysis of the data available on experimental neoplasies, it is possible to draw the conclusion that the quantitative relationships among the effects of various types of radiation on transplanted tumors are not dissimilar from those observed on non-neoplastic tissues. (auth)

37117 LEUKEMIA INDUCED BY THE THERAPEUTIC AND DIAGNOSTIC USE OF RADIATION. W. M. Court-Brown (Western General Hospital, Edinburgh). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 263-71. (In English)

Within recent years the increase in man-made background radiation, mainly from the medical use of x rays but also from radioactive fall-out, has caused concern as to whether such low levels of radiation dose can cause leukemia. The existing information on the causation of leukemia in man by ionizing radiation is derived from the study of persons exposed to heavy doses of irradiation; in particular extensive investigations have been made on the survivors of the atomic explosions over Hiroshima and Nagasaki, and on patients treated with x rays for ankylosing spondylitis. These observations permit some expression of opinion as to the possible nature of the relationship between radiation dose and the incidence of leukemia at the low levels of dose received in medical diagnostic radiology, and the still lower levels of dose experienced from radioactive fall-out. The present status of these studies is reviewed, and attention is paid to the inherent limitations of the present techniques of study. (auth)

37118 HYPOPLASTIC HEMOPATHIES DUE TO IONIZING RADIATIONS. A. Romanini (Università, Milan). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 273-99. (In Italian and English)

The etiopathogenesis of hypoplastic hemopathies due to ionizing radiations is shortly exposed. Histopathological data common to all hemopathies are synthetically reported and account is given to the characteristics which differentiate the three essential clinical forms: hypoplastic hemopathy from minimal long-acting panirradiations (usually due to occupational irradiation); hypoplastic hemopathy from a single rather high panirradiation (usually accidental or due to war); hypoplastic hemopathy from high but circumscribed and short-acting irradiation (mostly following severe antineoplastic radiotherapeutical treatments). The general aplastic anemia, which occasionally represents either the early or late results of the above described hemopathies, is then illustrated in detail. (auth)

37119 BONE MARROW TRANSPLANTATION IN HUMAN RADIATION PATHOLOGY. M. Lenzi (Università, Modena, Italy). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 301-27. (In Italian and English)

Effects of whole body irradiation in mammals with supralethal doses and the consequent recovery through heterologous and homologous medullary grafts are reviewed. Attempts at application to the field of human pathology caused by total irradiation, both accidental and therapeutical; and some radiobiological considerations on the isologous and autologous medullary grafts in man following partial irradiations, alone or with the administration of antimitotics are discussed. (auth)

37120 PROBLEMS, PATHOGENESIS AND SYMPTOMATOLOGY OF THE IRRADIATION SYNDROME. K. Fochem (Universitäts-Frauenklinik, Vienna). Ras. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 343-61. (In German and English)

A comprehensive survey of the irradiation syndrome is reported and an explanation is given as to why this signification has been chosen for the terms applied so far. The examinations on the syndrome comprise 530 patients who had a postoperative irradiation owing to genital carcinoma. The examinations comprise the symptomatology, the origin of the syndrome, experimental research on the creative factor, the dependence on the kind of radiation and its region as well as the quality of the rays and the possibilities of therapeutical influence. Examinations evidenced the fact that the age group from 40 to 50 years is one of the most susceptible. Furthermore the intensity of the syndrome depends on the expansion of the tumor, on the age of the patients, on their general conditions and finally on the pigmentary type. In most instances the initial symptoms will appear on the fourth day postirradiation. One of the very first symptoms, as a rule, is tiredness followed by anorexia, nausea, vomiting, and disorders of the intestine. These symptoms will abate gradually in the course of about four weeks. Of the various theories on how the syndrome arises only one will hold: the one which represents the view of intoxication caused by the decay of cells followed by a damage of the liver tissues. The examinations by means of various ways of irradiation have revealed the existence of a substance so far unknown in the skin or in the subcutaneous tissue as an essential factor for the instauration of the syndrome. Intensity of the radiation sickness depends also on the region of irradiation and on the quality of the x rays. Experimental examinations were comprised of the reaction of the liver, the blood, the histamine and cholinesterase of the serum during irradiation. (auth)

37121 HARMFUL EFFECTS DUE TO THERAPEUTIC EMPLOYMENT OF RADIOISOTOPES. U. Marinoni (Ospedale Civile, Busto Arsizio, Italy). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 363-411. (In Italian and English)

Harmful effects following diagnostic and therapeutic applications of radioisotopes in man are considered. The radioisotopes most frequently used in human physiopathology are reviewed. Radioactive iodine (I^{131}), because of its usefulness as a diagnostic test in thyroid pathology, has been used in a very large number of patients, including young women with hyperthyroidism that, once cured, experienced normal and even twin pregnancies. Menstrual cycle was studied during the isotope application, and radiation effect controls were possible on fetuses in two women treated with I^{131} accidentally during pregnancy. Therapeutic use of radioactive iodine has occasionally led to thyroid crisis and hypothyroidism; leukemic complications were not observed, even after eleven years in post-therapy controls. Clinical experience with radioactive phosphorus (P^{32}) in polycythemia rubra and chronic leukemia is not a very large one. Some possible harmful effects of the therapeutic use of colloidal radiogold (Au^{198}) are briefly dis-

cussed. Therapeutic use of Co^{60} in its chloride form for vesical tumors permitted control of some complications following the breaking of balloons containing the radioactive solutions. (auth)

37122 TELEGAMMATHERAPY OF LUNG CANCER. I. A. Peresleghin (State Inst. of Radiological Scientific Research, Moscow). Rass. Intern. Elettron Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 413-32. (In Italian and English)

In lung cancer therapy, radiotherapy has known lately a wide diffusion, in radical as well as palliative cures. Utilization of the new radiotherapeutical methods, and more particularly of telegammatherapy, offers considerably wider possibilities and indications for the treatment of lung cancer. The telegammatherapeutical modalities used gave satisfactory immediate results, not so much as regards the third and fourth stages of the disease, as in the stage where patients present rather serious conditions, with metastases of the mediastinum lymph nodes, and evident compression of the superior vena cava, esophagus, and other vital organs. Telegammatherapy was applied according to described modalities in peripheral forms of lung cancer and in the case of tumors situated in the upper third of the respiratory fields: in most cases, not only good immediate results were obtained, but the life of some patients was eventually prolongated by 17-20 months. Doses of 2500-3000 roentgens used in the most serious cases gave palliative results consisting of a reduction or disappearance of the pathological mass, improvement of breathlessness, disappearance of face edema and cyanosis, and improvement of the patients' general conditions. (auth)

37123 EARLY VASCULAR CHANGES FOLLOWING X-IRRADIATION. R. Laschi and A. Abbati (Università, Bologna). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 445-75. (In Italian and English)

Early alterations of capillary vessels after x irradiation have been studied on skin of guinea-pigs and on the frog's tongue. Observations on guinea pigs' skin showed that, after injection of vital staining, areas irradiated with 1250 and 2500 r appear more intensely colored than the surrounding non-irradiated ones; this fact is already to be observed at the 30th minute after irradiation. In vivo microscopic observation and histological examination of frog's tongue which had been irradiated with 2500 r, showed thickening of the vasal wall of small vessels, increasing deposition on it of red and white cells, and subsequent little haemorrhagic spots that gradually appeared on the whole surface of the tongue. At the same time, the blood flow becomes slower, sludging of red cells takes place and the caliber of the vessels is increased. These facts demonstrate that the response of small blood vessels to roentgen-irradiation is very early, so that it may be considered as one of the first tissue reactions induced on living structures by x-irradiation. (auth)

37124 EXPERIMENTAL AND CLINICAL STUDIES ON THE EFFECTS OF IONIZING RADIATION ON THE SKIN. J. Becker and K. H. Kaercher (Universität, Heidelberg). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 477-96. (In German and English)

The unavoidability of the skin reaction in the irradiation of superficial tumors is pointed out. For irradiation of large surfaces on the body, the sieve method with fast electrons proved useful. Impressive clinical evidence in certain cases is confirmed by histological and histochemical investigations of the epidermis and dermis. The special protective effect is clearly proved by the elastic tissue. Recent historadiographic examinations showed the same results. The decisive effect of external treatment during irradiation was demonstrated experimentally on albino rabbits. The powder treatment during irradiation proved distinctly superior than the ointment treatment. The reaction was markedly stronger in the case of ointments on a pure fat basis than of emulsions. The basis of the ointment appears to be of greater importance in determining the reaction, than the acting substances contained therein. (auth)

37125 PULMONARY ALTERATIONS DUE TO X- AND GAMMA RAYS: EXPERIMENTAL STUDY AND PRELIMINARY OBSERVATIONS ON PATHOLOGY. F. Fossati, C. Cavallero, and G. Luzzatti (Ospedale Maggiore, Milan). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 497-546. (In Italian and English)

The cytohistological patterns of lung changes due to electromagnetic radiations up to 200 kev have been known for a long time. The approximate relationships between the degree of such changes and the absorbed dose, the duration of the treatment and the time elapsed from the end of the irradiation have also been taken into consideration. On the contrary, the pathogenic mechanism, the chronological sequence and the interdependence of the elementary phases, and the histochemical evolution of such changes are not yet completely clear. Furthermore, little is known about the morphological aspects of lung changes due to electromagnetic radiations of approximately 1 Mev, such as those emitted by radiocobalt. In view of this, it was felt to be of interest to carry out a series of studies irradiating the lung of rabbits both with 200 kev x rays and gamma rays from Co^{60}, according to an irradiation scheme covering various methods of exposure and various levels of absorbed dose. The present studies were performed on four groups of 24 rabbits each. Each group was irradiated with single exposure doses from 1000 r to 8000 r, or with fractionated exposure doses from 2000 r to 16,000 r. The animals were killed after 6 hours, 24 hours, 4 days, 16 days, and 2 months from the end of the exposure. The experiments led to the identification of the morphological and histochemical lung changes during the early and intermediate phases of the process; particular attention was given to the elastic and reticular structures and to the amorphous ground substance. Pulmonary alterations after irradiation have been classified as primary and secondary. The former are constant, precocious, uniform, and arise in direct chronological relationship to the irradiation; the latter are late, inconstant and polymorphous, representing complications of the basic process. The primary changes reproduce the patterns of an interstitial pneumonia, present a cyclic, triphasic course, and persist some time after irradiation (two months in our experiments); histologically they are characterized by focal accumulations of epithelioid cells, elastosis, reticulosis and increase of PAS-positive material. Fractionation of the dose and the quality of rays used (x or gamma) seem to have influenced neither the morphology of the alterations nor their course; the differences observed have been more quantitative than qualitative. (auth)

37126 CLINICAL AND EXPERIMENTAL STUDY OF THE INFLUENCE OF IONIZING RADIATIONS ON SERUM COMPLEMENT AND ITS FRACTIONS. B. Bellion, F. Bazzola, S. Chiarle, G. Piancino, and L. Resegotti (Università, Turin). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 561-9. (In Italian and English)

The behavior of serum complement and of its fractions was studied in 18 patients affected by tumors treated with

high energy radiations and in 5 rabbits irradiated with low energy x rays. The complement, which normally increases in neoplastic subjects, was further increased following the irradiation. The mechanism of such a variation is discussed based on present knowledge of the significance of complement and on the action of ionizing radiation on neoplastic tissues and on the whole organism. (auth)

37127 EFFECTS OF RADIATIONS ON PURIFIED ENZYMES AND PROTECTIVE ACTIVITY OF SOME SULPHANILAMIDE DISULPHIDES. L. Brighenti and A. Falaschi (Università, Ferrara, Italy and CNRN, Italy). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 571-82. (In Italian and English)

The previous research on the inactivation of pure compounds of lactic dehydrogenase of yeast by means of ultraviolet and roentgen radiations, has been extended to other purified enzymes, extracted from animal tissues: liver alcohol dehydrogenase, heart lactic dehydrogenase and pancreas ribonuclease. It was possible to confirm that the inhibitory reaction caused by radiation shows a monomolecular trend, using both ultraviolet and roentgen radiation, and that it depends on the free radicals produced in the irradiated solution. The inhibitory effect of ultraviolet radiation is remarkably reduced by the presence of compounds of the type bis-(2,2'-amino-4,4'-sulfanilamide)-disulphide at concentrations ranging between 10^{-4} to 10^{-5}M. In these conditions it is possible to observe a decrease of the quantic yield of the inactivation reaction. The inhibitory effect of roentgen rays is reduced by the disulphide. (auth)

37128 THE EFFECT OF HYPEROXIA COMBINED WITH X-IRRADIATION ON THE DEVELOPMENT OF WALKER TUMOUR. G. Agati and L. Campi (Università, Turin). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 583-94. (In Italian and English)

A study was carried out on the influence of whole body irradiation on the growth of Walker tumor implanted in the rat. A sublethal dose (300 r) of x rays was delivered to the animals either before or after the implantation of the tumor both under normal conditions and during hyperoxia. The following phenomena were observed: the cutaneous size, volume and weight of the tumor; the histological picture of the tumor tissue, the frequency of metastases and the mortality ratio of the animals during the experimental period. Results obtained show that x irradiation carried out before the implantation of the tumor induces anergy which favors growth and metastatic spreading of the tumor and enhances mortality of the animals, while whole body irradiation carried out after the implantation of the tumor displays a marked anti-neoplastic effect which is revealed by the minor growth of the tumor, histological changes, lower number of metastases, and longer survival time of the animals. These effects of ionizing radiations are always enhanced by hyperoxia which induces respectively a worsening of the anergic syndrome or an increase of the cancerostatic effect. Possible mechanisms of action of the oxygen effect and its influence on tumoral tissues are discussed. (auth)

37129 DEFICIENCIES OF FETAL DEVELOPMENT IN ANIMALS EXPOSED TO X-IRRADIATION. L. Campi, I. M. Stoppa, and G. Sinistrero (Università, Turin). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 595-608. (In Italian and English)

Preliminary results of experimental research carried out to establish the action of ionizing radiation on the volume and size of embryos of female rats are presented. According to the results, a constant reduction both of the weight and of the volume of the treated embryos, was observed in comparison to the control animals. Hypotheses to explain the observed embryonic hypoplasia are suggested. (auth)

37130 VARIATIONS IN THE INTESTINAL ABSORPTION OF FATS IN CONNECTION WITH THERAPEUTICAL IRRADIATION OF THE ABDOMEN. G. De Giuli (Università, Florence). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 609-17. (In Italian and English)

Research on the changes of the fat utilization in the course of abdominal radiotherapeutic treatments is reported. In most cases in which a rather wide area of the abdomen was affected, there was an evident and sometimes remarkable decrease of fat utilization. While the treatment was still in progress, the absorption usually showed a stabilization and then an increase, but only some months after the treatment did it return to normal values. (auth)

37131 THE BIOLOGIC PROTECTION OF THE IRRADIATED SUBJECT AND ITS POSSIBLE INFLUENCE ON NEOPLASMS. N. Macarini (Università, Genoa). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 629-38. (In Italian and English)

From experimental and clinical data it is concluded that biological radiation protection does not exert an influence on neoplasm. Nonetheless, it is suggested that those substances be used which, when administered after a local irradiation of a neoplasm, display their general action on the radiation sickness, without diminishing the destructive action of radiation on the neoplasm. (auth)

37132 THE INFLUENCE OF SODIUM CYCLOHEXILSUCCINATE ON THE RADIOSENSITIVITY OF EPITHELIOMAS. M. Nannelli and C. Vallecchi (Università, Florence). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 639-59. (In Italian and English)

The employment of a radiosensitizer in the radiotherapy of tumors broadens the margin between doses of ionizing radiations which kill the tumor and damaging doses for the normal tissues. This was achieved by using a substance capable of slowing the glucide metabolism and consequently, according to the classical principles of Warburg, capable of damaging the tumoral cells on a larger scale in comparison with normal cells. The compounds which were tried for such a scope are structurally analogous to glucose, and the most active was cyclohexanol. The inhibiting action of cyclohexanol on anaerobic glycolysis was demonstrated by finding that the preparation inhibits glucose fermentation produced by yeast and that it is capable of reproducing the Lundsgaard's effect on the isolated gastrocnemius of the frog. The radiosensitizing effect of cyclohexanol was documented with evidence by two tests; the anticipation of the roentgen-depilatory effect (on the rabbit ear) the latency of which was shown to be half in comparison with the controls; and the high mortality shown in irradiated rats treated with cyclohexanol in comparison with controls. In view of the employment of cyclohexanol in human therapy, toxicity was determined in various experimental animals. In the course of these tests a depressive action of cyclohexanol on the nervous system, until the provocation of narcosis, was discovered. The clinico-therapeutical observations were carried out on 40 cases of skin epithelioma. Patients were treated (both with plesio-roentgentherapy and radium implantation) with dosages equal to half of the routine dosage, equivalent to 2000-3000 r; the radiosensitizer (g 2 a day by mouth, or g 1 for parenteral way) was administered for the whole period of radiological therapy and sometimes for a longer period. Clinical recovery, controlled at a distance of time, was reached in 73% of cases. The percentage of recovery ob-

tained, with a technique which only uses half of the radiating routine load, seems to be very high. Therefore, cyclohexanol is attributed with a radiosensitizing power advantageous in the radiological therapy of skin tumors. (auth)

37133 A COMPARISON AMONG THE EFFECTS OF DIFFERENT TYPES OF RADIATION: INFLUENCE OF THE TIME FACTOR. P. G. Paleani Vettori (Università, Rome and CNRN, Italy). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 661-74. (In Italian and English)

Time-dose relations are studied by means of Strandquist's equation in patients under treatment with conventional x rays, Co^{60} gamma radiation, and fast electrons produced by a betatron. Dose effect curves of mucosal reactions showed a different slope with the three kinds of radiation. Skin reactions after fast electron irradiation are compared with data for conventional x rays and neutrons. (auth)

37134 A NEW HEPATO AND RADIOPROTECTIVE AGENT: 2-METHYLPIPERAZINE DITHIOFORMATE. R. Paoletti, P. Paoletti, and R. Vertua (Università, Milan). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 675-96. (In Italian and English)

The pharmacological properties of a series of piperazine dithioderivates were studied and the results obtained with the most active of these derivates, the 2-methylpiperazine dithioformate (DTP), are reported. Characteristics of this substance are a low toxicity, a hepatoprotective action similar to that of methionine, and a radioprotective action comparable to that of cysteamine, against the lesions caused by x-irradiations as well as by radiomimetic agents. (auth)

37135 ON THE SO-CALLED LATE OR THERAPEUTICAL RADIONECROSIS. M. Piemonte (Istituto del Radium degli Spedali Civili, Brescia, Italy). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 697-708. (In Italian and English)

Anatomical and clinical characteristics of the alteration known as late or therapeutical necrosis are reviewed and the most characteristical aspects of this alteration in various anatomical sites are discussed. Radionecroses of the tongue, of the palate, of the skin, of the uterus cervix, of the vulva, and of the penis are illustrated. (auth)

37136 RESPONSE OF WHOLE BODY IRRADIATED ORGANISMS AFTER AN INCREASE OF SOME OXIDO-REDUCTION PROCESSES. G. E. Zarabini, C. Cheli, G. Marchetti, G. Voltolini (Università, Bologna). Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 709-28. (In Italian and English)

Three groups of guinea pigs previously brought to hyperthyroid state by means of thyrotropin and groups of hyperthyroid animals in normal metabolic conditions due to the administration of a hypothermic cocktail were submitted to lethal and sublethal doses of irradiation. Lethal dose curves were obtained which compared with the curve from control animals, show that the radiosensitivity in the hyperthyroid animals is rather higher than in the normal ones, the rate being 1.46 for the first group, while in the second group the radiosensitivity was similar to that of normal animals. It is concluded that in the hyperthyroid animal the higher radiosensitivity is for the most part due to the increase in general metabolism. (auth)

37137 REACTION OF THE CIRCULATING ELEMENTS OF THE PRELYMPHNODE LYMPH OF THE LUNG TO PANIRRADIATION WITH TELECOBALT ^{60}Co. G. Ottaviani (Università, Parma, Italy), M. Lenzi, M. Satta, and G. Bassani. Rass. Intern. Elettron. Nucl., 7; 5 Congr. Nucl., Rome, 1960, 3: 729-42. (In Italian and English)

Results of experimental investigations carried out by means of microcinematography (with a phase contrast microscope) on the effects of telepanirradiation with cobalt-60 on the circulating elements of the lymph are presented. The observations, carried out in comparison with what was previously observed following the irradiation of the same material with 200 kv x rays, permitted the differences existing in the biological effect between the two types of irradiation to be distinguished. These differences become apparent when the measurement between the different types of irradiation was considered as administered dose, but they are practically not observable when one considers the amount of absorbed dose. (auth)

Radiation Sickness

37138 (LADC-5747) DOSE RATE EFFECTS ON LETHALITY OF MICE EXPOSED TO FISSION NEUTRONS. J. F. Spalding, J. A. Sayeg, and O. S. Johnson (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 15p. (CONF-205-1)

For Presentation at International Atomic Energy Agency Symposium on the Biological Effects of Neutrons Irradiation, Upton, N. Y., Oct. 1963.

RF strain virgin female mice 4 months of age were used to determine LD_{50}^{30}'s for fission neutrons delivered at dose rates of 10 and 2×10^3 rads/min, and for γ rays delivered at 9 rads/min. In addition, the median lethal dose determinations for fission neutrons and for γ rays delivered by the fractionation method (single, acute sublethal exposures at 14-day intervals) were done. The LD_{50}^{30} for fission neutrons was found to be independent of dose rate, whether the dose was delivered at 10 or at 2×10^3 rads/min. Under the conditions of this experiment, the RBE for fission neutrons was between 3.5 and 4.5 regardless of whether the acute LD_{50}^{30} or fractionated MLD method was used. The repair half time for biological repair from fission neutron injury was estimated at 6 days for the RF strain female mouse. (auth)

37139 (TID-19388) STUDIES ON GASTROINTESTINAL MOTILITY AND ABSORPTION OF GLUCOSE AFTER X-IRRADIATION (thesis). Philip H. Smith (Rochester, N. Y. Univ. Atomic Energy Project). 1953. 43p.

Results are reported from studies of the effects of x irradiation on gastrointestinal motility and the absorption of glucose in guinea pigs. It was concluded that there is no clear-cut evidence of impaired absorption of carbohydrates or intestinal stasis in irradiated guinea pigs, but that the rate of passage of glucose out of the stomach is decreased after irradiation. (C.H.)

37140 (AEC-tr-5996) CHANGES IN THE COMPOSITION OF WATER-SOLUBLE HEPATIC AND BLOOD SERUM PROTEINS IN THE EARLY STAGES OF RADIATION SICKNESS. E. M. Belyaeva. Translated from p.101-8 of "Proceedings of Symposium on Biological Effects of Ionizing Radiation at the Molecular Level, held in Brno, July 2-6, 1962." (a publication of the International Atomic Energy Agency, Vienna, 1962). 8p. (STI/PUB/60 (p.101-8))

Results are reported from electrophoretic examinations of the total water-soluble hepatic proteins, proteins in components of individual cells, and blood serum proteins of rats and rabbits exposed to lethal doses of x and γ radiation. Modifications of immunological characteristics of the proteins induced by irradiation were studied using spe-

cific precipitation in gel. No direct relation was established for the radioinduced changes noted in protein composition and the pathogenesis of radiation sickness. (C.H.)

37141 (JPRS-20948) THE PROBLEM OF TRANSPLANTATION OF HEMOPOIETIC TISSUE IN THE TREATMENT OF RADIATION INJURY. P. D. Gorizontov, M. F. Shitneva, and M. N. Trushina. Translated from Patol. Fiziol. i Eksperim. Terapiya, [7]; No. 3, 15-20(1963). 10p. (OTS-63-31688)

The transfusion of homologous embryonic liver cells or of bone marrow cells in rats irradiated with a dose of 750 r (LD_{100}) has little influence on the survival of the animals. However, the combination of this therapy with biomycin treatment saved 50–75 percent of the animals from death by the 30th day. By the 120th day, because of death from homologous second disease [production of crossreacting antibodies] the number of rats which survived was reduced by approximately a half. For the treatment of acute radiation sickness in rats transfusion of a suspension of embryonic liver cells was more effective than the transplantation of bone marrow cells. The effectiveness of the therapy depended on the number of cells and the times of their injection. Best results were obtained from transfusions given in the first few hours or first day after irradiation with a maximum number of cells in the suspension ($20\text{-}22.6 \times 10^7$). Transplantation of homologous bone marrow to dogs irradiated with a dose of 300 r (LD_{95}) somewhat increased the effectiveness of comprehensive therapy. The mechanism of the therapeutic effect of hemopoietic tissue transplantation cannot be reduced simply to the effect of its acceptance (replacement therapy). There is reason to believe that transplantation acts on the metabolic tissue processes, particularly on the recipient's DNA. (auth)

37142 INFLUENCE OF METALLIC IONS ON RADIATION RESISTANCE. H. Altmann, G. Stehlik, and K. Kaindl (Osterreichische Studiengesellschaft für Atomenergie GmbH, Vienna). Atompraxis, 9: 255-9(July 1963). (In German)

Studies were made of the stabilizing effects of various metallic ions which form compounds with nucleic acids or with free nucleotides. The question of increased RNA decomposition, which is found in various cells following ionizing irradiation, was considered with reference to the metallic-ion stabilization of RNA. It is shown that this stabilizing effect is more important than the inhibition of ribonuclease through free metallic ions. In regard to the question of radio-sensitization through copper, it is shown that this effect appears only with free nucleotides. In polymeric nucleic acids, the energy-transport mechanism apparently causes a separation of cations, so that a protective effect on the part of these metallic ions can be detected even in regard to basic changes. The mechanism of energy transport in the polymeric RNA chain is discussed in connection with the separation of trace elements. (auth)

37143 CHANGES OCCURRING IN THE EXCRETION OF RADIORUBIDIUM BY SALIVA IN RATS AFTER WHOLE-BODY IRRADIATION. M. Rakovič, J. Ondráčková, and V. Gregora (Charles Univ., Prague). Nature, 199: 1008-9 (Sept. 7, 1963).

Whole-body x irradiation caused an increase in the excretion in saliva of injected Rb^{86} in rats. (C.H.)

37144 WATER-SOLUBLE ATP-ASE IN THE ORGANS OF RATS AFFECTED WITH POLONIUM. M. G. Zotova. Radiobiologiya, 3: 21-3(1963). (In Russian)

Changes of adenosine triphosphatase activity under conditions of radiation sickness induced by polonium were studied. The investigation was carried out using as a model acute radiation sickness induced in rats by a single subcutaneous injection of polonium in the amount of 0.1 mC/kg. Death of the animals ensued on the 12th-16th day. Animals were decapitated on the 1st, 3rd, 5th, 7th, 10th, and 15th days after injury. Activity of the enzyme was determined in a water-soluble protein fraction of liver, spleen, kidneys, and brain. The change in the activity of the enzyme was estimated from the increase of inorganic phosphorus, which was determined by colorimetry. In healthy animals, the kidney and liver exhibit greater enzymic activity, while the spleen and brain display a lesser one. Slight fluctuations in the activity of the enzyme were noted in each investigated organ. Polonium-injected animals showed a distinct decrease of adenosine triphosphatase activity in all investigated organs. Depression of the enzymic activity progressed until the 3rd to 5th day after injury at which time it gradually increased. At no time did enzymic activity in the injured animals reach the level of the lower boundary of normal animals. Thus it was concluded that the damage of sulfhydryl enzymes plays a definite role in the mechanism of radiation injury. (H.M.G.)

37145 INFLUENCE OF CARBON MONOXIDE ON DEVELOPMENT OF THE ACUTE RADIATION SYNDROME. V. V. Kustov. Radiobiologiya, 3: 53-8(1963). (In Russian)

Studies were carried out to investigate whether the therapeutic action of CO in radiation sickness is connected with its specific action on tissue metabolism. White male rats were given a 550-r dose of x ray, and poisoned with CO by a dynamic method. Three series of experiments were performed. In the first series, the irradiated rats were poisoned with CO (11 mg/liter) immediately, and then on the second, third, and fourth day after irradiation. In the second series, rats were exposed to the action of CO (1.5-1.6 mg/liter) immediately and then five days in succession after irradiation, for an exposure period of one hour. In the third series of experiments, the animals were poisoned with CO (0.32-0.34 mg/liter) at once during one hour, and then during six successive days after irradiation. Results indicated that the use of CO during the first days after irradiation may exert a definite positive effect on the course of acute radiation sickness only in the case when it produces a severe CO intoxication. Further it was learned that the positive effect of CO is preserved when applied at more remote periods after the irradiation. Special experiments, designed to study the significance of hypoxemic and tissular effect of CO on the course of radiation sickness, were performed to explain the mechanism of the therapeutic effect of CO in acute radiation sickness. It was concluded that the positive effect of CO on the course of acute radiation sickness in rats is due to its specific action upon tissue metabolism. (H.M.G.)

CHEMISTRY

General and Miscellaneous

37146 (AAEC/TM-205) THE FIXATION OF CAESIUM ON AUSTRALIAN MINERALS. PART 1. VERMICULITE MINERALS. C. R. Frost (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). July 1963. 14p.

Samples of vermiculite from Young River, W. A., and Kingaroy, Qld., were tested for cation-exchange capacity using batch and column experiments. The better material, Young River vermiculite, was given more exhaustive column tests to determine the optimum particle size and to investigate its selectivity for cesium ions in the presence of higher concentrations of competing ions. At the optimum particle size of (−30+60) B.S.S. the cation exchange capacity of Young River vermiculite was approximately 70 meq/100g. With competing cations in solution, cesium breakthrough occurs after a very small volume of influent has passed through the bed. It was concluded that neither of these vermiculite minerals would be suitable for medium level radioactive waste treatment. (auth)

37147 (AAEC/TM-206) THE FIXATION OF CAESIUM ON AUSTRALIAN MINERALS. PART 2. ZEOLITE MINERALS. C. R. Frost (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). July 1963. 21p.

Samples from possible zeolite bearing deposits were tested for cation exchange capacity using batch and column experiments. The best material, Eagleton Quarry pink shale, was given more exhaustive column tests to determine the effect of mineral particle size, influent flowrate, and the presence of competing cations on cesium breakthrough. Diffusion of cesium ions through the mineral particle controls the ion exchange process. At the optimum size range of (−30+36) B.S.S., the cation exchange capacity of Eagleton Quarry pink shale is approximately 60 meq 100g. With competing cations in solution, cesium breakthrough occurs after very small influent volumes have passed through the mineral bed and it was concluded that none of the minerals tested would be suitable for medium level radioactive waste treatment. A sample of clinoptilolite from Hector, California was also tested for cesium selectivity. (auth)

37148 (TID-19367) ORGANOMETALLIC COMPOUNDS OF THE ACTINIDES. Quarterly Progress Report, May 15, 1963–August 15, 1963. (Ethyl Corp. Research and Development Dept., Detroit). Contract AT(11-1)-999. 18p.

Work was continued on the compound referred to as $U(C_5H_5)_3 \cdot 2X$ in the last quarterly report. It was noted at that time that the compound was probably $U(C_5H_5)_3 \cdot 2THF$ or $U(C_5H_5)_3(C_4H_8O)_2$, where THF = tetrahydrofuran. Further work indicates the latter formula to be the correct one. The compound was synthesized by an independent route and the corresponding methoxide and phenoxide were prepared. (auth)

37149 (TID-19397) THE PREPARATION, PROPERTIES AND STRUCTURE OF CARBONATE GLASSES. Interim Report, October 1, 1962–August 1, 1963. Samuel Faile, Della M. Roy, and O. F. Tuttle (Pennsylvania State Univ., University Park). Aug. 29, 1963. Contract AT(30-1)-2887. 22p.

The principal objective of this research is to explore pressure-temperature conditions of formation of unusual glasses containing large amounts of volatile components, and to measure their physical and chemical properties. The principal glasses investigated included: (A) those for which there is no conventional network former, and (B) modification of common network formers by volatile constituents. Under group (A) glasses were prepared which are composed entirely of carbonates and many glasses were prepared with mixed volatile components, including carbonates. Under (B) glasses were prepared by the addition of gases such as CO_2, H_2O, A, F, Cl, and SO_3, under elevated pressures in the conventional glass composition and the solubility of volatile-containing compounds such as hydroxides, carbonates, sulfates, and nitrates, was determined in the conventional glasses. Research on the pure carbonate glasses has revolved around substitutions which would permit extending the properties of these glasses. It was found possible to maintain the glass structure by fairly large additions of lanthanum carbonate and minor additions of such things as manganese and lead. It now appears that there will be no wide spread area of carbonate glasses, but only restricted compositions in the vicinity of the potassium-magnesium composition. Complex volatile glasses containing no silica or other common network former were also prepared over a narrow range of compositions. Sulfate, hydroxide, fluoride, carbonate were put in as compounds in glass-forming mixtures. The incorporation of volatile compounds into conventional glasses was also investigated. The alkali-lime-silica glasses, for example, will take large amounts of water into solution; it is, in fact, possible to prepare glasses having all compositions intermediate between a window glass composition and pure water at high pressure and the corresponding physical properties of the glass change in more or less a continuous manner. For example, it is possible to prepare glass having the consistency of putty or the consistency of brittle substance. Under the pressures utilized, water seems to be one of the most soluble volatile constituents, although CO_2, SO_3, and F also can enter into these glasses readily. Apparently, pressure is the controlling factor and if pressure could be increased considerably over that available for these experiments, presumably other volatiles would also dissolve in the glasses. Many of these glasses, both carbonate and silicate glasses with volatiles, can be vesiculated by heating at atmospheric pressure. In many cases, the volume of the resulting product is 100 or more times that of the initial glass, so that a foam-like glass is produced. (auth)

37150 THE SEPARATION OF HYDROGEN, HYDROGEN DEUTERIDE, TRITIUM HYDRIDE, DEUTERIUM, TRITIUM DEUTERIDE, AND TRITIUM MIXTURES BY GAS CHROMATOGRAPHY. Edward H. Carter, Jr. and Hilton A. Smith (Univ. of Tennessee, Knoxville). J. Phys. Chem., 67: 1512-16(July 1963).

The resolution and analysis of the components in hydrogen–deuterium–tritium mixtures were accomplished by gas chromatography at 77°K. Tritium was incorporated into the sample mixtures in tracer quantities ($N_{T_2} = 10^{-4}$, 2×10^{-1} mC per standard ml). Helium, hydrogen, and neon were employed as carrier gases with several columns containing activated alumina and ferric oxide on alumina. Varying degrees of isotope separation were observed with different carriers, adsorbents, and conditions

of column activation. Separation factors for the hydrogen isotopes and isomers on various columns at 77°K were calculated. Flow-modified ionization chambers and a Cary Model 31 vibrating reed electrometer equipped with a 10^{10} (or 10^{11}) ohm leak resistor were employed in series with thermistor-equipped katharometers for the detection of radioactive and non-radioactive hydrogen isotopes. Outputs from the electrometer and the katharometer were recorded simultaneously on two synchronized Brown electronic recorders. Simultaneous ionization chamber and katharometer detection of para-hydrogen, ortho-hydrogen, hydrogen deuteride, and deuterium was observed. (auth)

37151 CONDUCTANCE OF THE ALKALI HALIDES. VII. CESIUM CHLORIDE IN DIOXANE–WATER MIXTURES AT 25°. Jean-Claude Justice and Raymond M. Fuoss (Yale Univ., New Haven). J. Phys. Chem., 67: 1707-8(Aug. 1963).

The conductance of cesium chloride at 25° was measured in dioxane–water mixtures covering the range of dielectric constant $12.73 \leq D \leq 78.54$. As a function of concentration, the data can be reproduced by the Fuoss three-parameter conductance equation. As in the case of the other alkali halides studied in dioxane–water mixtures, the contact distance a varies with composition of solvent and according to the method of computation. The corrected value for Λ_0(CsCl, H_2O, 25°) was found to be 152.81. From this value and data in the literature, $\lambda_0(Cs^+) = 76.44$.(P.C.H.)

37152 PURE QUADRUPOLE RESONANCE OF CHLORINE (Cl^{35}) IN POTASSIUM TETRACHLOROPLATINATE (II). E. P. Marram (Arthur D. Little, Inc., Cambridge, Mass.), E. J. McNiff, and J. L. Ragle. J. Phys. Chem., 67: 1719(Aug. 1963).

Quadrupole coupling constants for Cl^{35} in potassium tetrachloroplatinate were calculated on the assumption that the asymmetry parameter is zero. Spectra were obtained with a conventional Zeeman-modulated superregenerative spectrometer using lock-in detection. The quadrupole coupling constants were calculated as 36.26, 36.14, and 35.85 at –196, –79, and 0°C, respectively. (P.C.H.)

37153 THE USE OF SOLVENT EXTRACTION TECHNIQUES IN THE STUDY OF CHEMICAL EQUILIBRIA. David Dyrssen (Royal Inst. of Tech., Stockholm). Nucl. Sci. Eng., 16: 448-55(Aug. 1963).

Solvent extraction studies that are used to study complex formation in the aqueous solution as well as in the organic solvent are considered. In this liquid distribution method low metal concentrations can be used and the concentrations can generally be determined radiometrically. With proper choice of conditions, polynuclear reactions (e.g., formation of polynuclear hydroxo complexes) can be avoided, radioelements can be investigated, and the amount of complexing agent bound by the central ion can be neglected. Equilibria that were investigated include the following types: complexing in the aqueous phase with inorganic (e.g., OH^-, Cl^-, SO_4^{2-}) and organic ligands (e.g., CH_3COO^-, $C_2O_4^{2-}$), where the solvent extraction system is used to measure the concentration of the free metal ion; complexing in both phases with extracting agents (e.g., acetylacetone, oxine); residual coordination in neutral metal chelates or salts (e.g., $UO_2(NO_3)_2$, $UO_2(TTA)_2$, $UO_2(R_2PO_4)_2$); extraction of mixed chelate complexes. Mention is also made of systems that are not categorized by the above types. (auth)

Analytical Procedures

37154 (HW-73913) CHARACTERISTICS OF A LARGE NEUTRON MODERATOR FOR ACTIVATION STUDIES. J. DePangher, L. L. Nichols, and R. A. R. Kent (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1, 1962. Contract AT(45-1)-1350. 40p.

A large cylindrical moderator, 3 feet in diameter and 3 feet long, is described as a tool for neutron activation studies. The neutron source at the center of the moderator is a thick Be target bombarded by about 15 μamp of 1.85-Mev deuterons. Typical radiation characteristics in terms of gamma-ray dose rates and of thermal-neutron fluxes are given for a few positions inside the moderator. Detector characteristics for measuring induced radioactivity are also described. (auth)

37155 (WCAP-6031) NUCLEAR MATERIALS CONTROL SYSTEM (NMCS). PHASE II. CONTINUOUS MONITORS FOR URANIUM AND PLUTONIUM IN A CHEMICAL PROCESSING PLANT. E. R. Rosal, W. E. Foster, C. C. Thomas, Jr., and H. Ginsburg (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Dec. 1, 1959. Contract AT(30-1)-2176. 72p.

Various instruments suitable for the continuous monitoring of plutonium and uranium in a nuclear fuels reprocessing plant under the jurisdiction of a Nuclear Materials Control System (NMCS) were evaluated. The program emphasized the selection of plant-proven instruments which would provide independent and reliable supplementary information concerning the plant inventory. Descriptions and specifications for each instrument and its recommended point(s) of application in the reprocessing plant are given. Tamper-resistant features to protect the integrity of the instrument readings are discussed. (auth)

37156 A METHOD FOR THE DETERMINATION OF CAESIUM-137 IN SEA WATER. A. Morgan and G. M. Arkell (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Health Phys., 9: 857-62(Aug. 1963).

A method has been developed for the determination of Cs^{137} in sea-water. The acidified sample, containing added ammonium nitrate and cesium carrier, is passed through a column containing ammonium 12-molybdophosphate (AMP) mixed with an equal weight of asbestos to give adequate porosity. The cesium is retained quantitatively on the AMP (which acts as a selective cation exchanger) together with a small fraction of the natural rubidium and potassium present in the original sample. After treatment to separate the rubidium and potassium (both of which contain natural beta-emitting nuclides) the Cs^{137} is counted. The principal advantage of this method is the high radiochemical purity of the separated Cs^{137} which may be assayed by beta counting. With the use of low-background beta counters, levels of approximately 0.1 pc/l may be determined on a 25-l sea-water sample with a 95 per cent confidence limit of ±0.015 pC/l. The results of measurements on sea-water samples collected from the North Atlantic and coastal waters round the British Isles during 1961 and 1962 are reported. (auth)

37157 PAPER CHROMATOGRAPHIC SEPARATION OF ZIRCONIUM AND NIOBIUM. A. Moghissi and E. Edgueer (Kernforschungszentrums, Karlsruhe, Ger.). J. Chromatog., 11: 389-93(July 1963). (In German)

Zirconium and niobium were separated by paper chromatography with the solvent system methyl ethyl ketone–dioxane–water (5:1:1), 0.25 M in oxalic acid and 0.1 M in hydrochloric acid. The R_F values in the system are 0.1 for zirconium and 0.4 for niobium. Under the same conditions the R_F of molybdenum is 0.7. (auth)

37158 CHROMATOGRAPHIC SEPARATION AND IDENTIFICATION OF SOME INDIVIDUAL RARE EARTHS

ON PAPER BY MEANS OF FLUORESCENCE. G. Alberti and M. A. Massucci (CNEN, Rome and CNR, Rome). J. Chromatog., 11: 394-400(July 1963). (In English)

Conditions for the formation of some uv fluorescent rare earth compounds were studied. It was found possible to detect some rare earth ions by fluorescence on paper with high sensitivity. The spot tests employed were very specific for Eu, Sm, (sodium tungstate as reagent; red fluorescence; identification limit: Eu 10^{-3} γ; Sm 10^{-2} γ), for Dy (sodium tungstate as reagent; whitish pink, fluorescence; identification limit: $2 \cdot 10^{-3}$ γ) and for Tb (sodium oxalate as reagent; yellow-green fluorescence; identification limit $2.5 \cdot 10^{-2}$ γ). Separation of the rare earth group from interfering substances was carried out by extracting with mesityl oxide (which removes tetravalent cations) followed by extraction with tributyl phosphate–HNO_3. The individual rare earths were separated on Amberlite SA-2 ion-exchange paper employing aqueous lactic acid as eluent. (P.C.H.)

37159 A NON-DESTRUCTIVE RADIOANALYTICAL METHOD FOR THE DETERMINATION OF GALLIUM IN SUBSTITUTED YTTRIUM IRON GARNETS. J. Paul Cali (Air Force Cambridge Research Labs., Bedford, Mass.), Joseph R. Weiner, and John J. O'Connor. Nature, 199: 1081-2(Sept. 14, 1963).

A rapid, non-destructive method for determination of gallium in yttrium iron garnet was undertaken, and a non-destructive radioanalytical scheme based on neutron activation and γ-ray pulse-height analysis was developed. Spherically shaped, gallium-doped garnet samples were placed in an irradiation container together with a suitable amount of pure gallium metal and a garnet containing no gallium. Samples and standards were irradiated for one min at a thermal flux of 8×10^{12} neutrons cm^{-2} sec^{-1}. Quantitative results were obtained by measurement of the areas under the 0.83 Mev peaks after application of the usual corrections. Gamma spectra were taken four hr after irradiation for gallium yttrium iron garnet, gallium standard, and yttrium iron garnet. Percent gallium by weight in gallium yttrium iron garnet was found to be 12.2 ± 0.6; in gallium standard 10.0 ± 0.5; and in yttrium iron garnet 9.5 ± 0.5. A search of the literature indicated that no single interfering element or combination of elements could give a spectrogram with γ-energies and decay characteristics similar to those found. (H.M.G.)

37160 UTILIZATION OF INCREASED SENSITIVITY OF X-RAY FLUORESCENCE SPECTROMETRY DUE TO POLARIZATION OF THE BACKGROUND RADIATION. K. P. Champion and R. N. Whittem (Australian Atomic Energy Commission, Sydney). Nature, 199: 1082(Sept. 14, 1963).

It is suggested that marked improvement in x-ray fluorescence analysis would be possible with a polarization analyzer. Although such a device is present on most x-ray spectrometers in the form of the analyzing crystal used to disperse the spectrum, the optics of commercial spectrometers are usually arranged so that when the analyzing crystal is in position for optimum polarization, the sample and analyzer planes are parallel. By rotating the x-ray tube and sample holder about the axis of the collimator on a Phillips PW 1520 instrument, scattered radiation is considerably decreased for analyzer settings in the vicinity of 20–90°. Implications for analytical chemistry are illustrated. (H.M.G.)

37161 QUANTITATIVE DETERMINATION OF RARE EARTHS, RUTHENIUM, PALLADIUM AND PLATINUM IN METALLIC BERYLLIUM BY ACTIVATION METHOD. V. N. Zamyatnina and L. A. Chikisheva. Radiokhimiya, 5: 294-8(1963). (In Russian)

A radiochemical separation and purification of Ru^{105}, Pd^{109}, and Pt^{197} from metallic beryllium is described. A method was developed for determining the total sum of rare elements according Dy^{165} with radiochemical separation in metallic beryllium. An activation method was used for determining the content of Ru, Pd, Pt, and the total of rare earths in beryllium specimens. (R.V.J.)

37162 COMPARATIVE STUDY OF REAGENTS FOR PHOTOMETRIC DETERMINATION OF PLUTONIUM. A. A. Nemodruk, P. N. Palei, and N. E. Kochetkova. Radiokhimiya, 5: 335-42(1963). (In Russian)

Photometric methods of Pu(IV) determination by thoron I and II, arsenazo I, II, and III, and chlorophosphonzao I and III were compared. Arsenazo III and chlorophosphonazo III proved to be the most sensitive and efficient reagents for plutonium(IV). (R.V.J.)

37163 SEPARATION OF PRASEODYMIUM AND NEODYMIUM BY ELECTROLYSIS ON MERCURY CATHODE. V. P. Shvedov and P. G. Antonov. Radiokhimiya, 5: 342-6 (1963). (In Russian)

Separation of Pr and Nd by electrolysis in aqueous solutions of acetate salts in presence of lithium tartrate as reagent was achieved with separation coefficient from 30 to 60. Optimum conditions for 0.02M Pr and 0.02M Nd were found with 0.34M lithium tartrate, 7.7 $\mu a/cm^2$ current density, at 20°C and electrolysis time of 60 min. (R.V.J.)

37164 DETERMINATION OF CERTAIN RARE EARTHS BY RADIOMETRIC TITRATION USING CUPFERRON. B. M. Mar'yanov and V. V. Serebrennikov. Radiokhimiya, 5: 347-50(1963). (In Russian)

Radiometric determination of Ce, Nd, and Lu by titration with cupferron was achieved with the order of error of 5% for Nd and Lu (content 0.016 to 0.35 mg/ml) and 4% for Ce (content 0.045 to 0.25 mg/ml). (R.V.J.)

37165 POSITIVE ASTATINE ION IN NITRIC ACID SOLUTION. Fu-ch'ing Wang, Yu. V. Norseev, V. A. Khalkin, and T'ao-nan Ch'ao. Radiokhimiya, 5: 351-5(1963). (In Russian)

The presence of positive astatine ion in acid solutions of $H_2Cr_2O_7$ with $0.4M < HNO_3 < 1.25M$ was indicated by electromigration and ion exchange method. The positive cation charge is 1+. (R.V.J.)

37166 DETERMINATION OF MsTh(I) BY MEASURING MsTh(II) β EMISSION IN A RADIUM PREPARATION, SEPARATED FROM RADIOACTIVE ELEMENTS. N. G. Syromyatnikov, F. A. Mukashev, and L. A. Kapatsinskaya. Radiokhimiya, 5: 356-60(1963). (In Russian)

Determination of MsThI (Ra^{228}) by β emission from MsThII (Ac^{228}) in admixture-free radium is described. A complete separation of radium from radioactive (Ac, Bi, Pb, and Th) admixtures was achieved by precipitation of radium-barium sulfates in 4.5 to 5.0 pH complexone III. (R.V.J.)

37167 RAPID METHOD FOR RADIUM SEPARATION FOR MEASURING EMISSIONS. P. I. Chaikin and N. V. Golubev. Radiokhimiya, 5: 397-9(1963). (In Russian)

A rapid analysis of 5- to 6-g specimens (with Ra^{226} content 7×10^{-12} g and Th^{232} 0.7×10^{-4} g) in a corundum crucible for specimen analysis with sodium peroxide and citric and hydrochloric acid for stabilizing the solution is described. Tabulated data for various rock specimens indicates a sufficient accuracy of the method. (R.V.J.)

37168 DETERMINATION OF LOW-LEVEL RADIOACTIVITY IN WATER. PART 2. Werner N. Grune (Georgia Inst. of Tech., Atlanta), Ross B. Hughes, and George W. Wilson. Water Sewage Works, 110: 69-70(Feb. 1963).

The use of a membrane filter to retain activity, with retention of up to 3% with relatively high concentrations of uranyl acetate is described. Alpha plus beta activity retained was found to be lower in water samples containing 1805 ppm added solids, probably due to larger self-adsorption factor. Experiments were also made with flocculating agents, with acetic acid or calcium chloride, followed by heating to boiling point, which gave the fastest and most complete results. Factors that affect ion exchange, and that must be considered in selecting a resin for concentrating nuclides by the ion exchange method, are ionic radius, activity of ion, valence state, hydration of resin and ion, diffusion rate through resin, flow rate through column, and temperature. Resin cross linkage, mesh size, capacity for exchange, and stability are also important. (Public Health Eng. Abstr., vol. 43: Sept. 1963)

37169 DETERMINATION OF LOW-LEVEL RADIOACTIVITY IN WATER. PART 3. Werner N. Grune (Georgia Inst. of Tech., Atlanta), Ross B. Hughes, and George W. Gibson. Water Sewage Works, 110: 97-9(Mar. 1963).

A method of wet ashing ion-exchange resins by the use of concentrated perchloric, nitric, and sulfuric acids, followed by measurement of activity of the ashed resins is described. A dry ashing procedure with magnesium nitrate, ammonium nitrate, and hydrogen peroxide was investigated and found to be less practical than direct dry ashing in a muffle furnace; the latter procedure is described. Elution was considered impractical as a rapid radio-assay technique. (TCO)

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Refer also to abstracts 37686, 37689, 37690, 37691, 37692, 37697, 37698, 37699, 37702, 37708, 37710, 37711, 37772, 37777, 37778, 37779, 37780, 37782, 37783, 37785, 37786, 37787, 37788, 37789, 37792, 37793, 37794, 37795, 37796, 37797, 37800, 37801, 37803, 37804, 37805, 37807, 37808, 37810, 37812, 37813, 37816, 37819, 37823, 37826, 37827, 37830, 37832, 38029, 38030, 38035, 38044, 38047, 38050, 38051, and 38078.

37170 (ORNL-TM-668) PHASE RELATIONSHIPS IN THE URANIUM–CARBON SYSTEM AS DETERMINED BY CHEMICAL, METALLOGRAPHIC, AND X-RAY DIFFRACTION METHODS. L. M. Ferris, M. J. Bradley, and R. J. Gray (Oak Ridge National Lab., Tenn.). Sept. 3, 1963. Contract [W-7405-eng-26]. 19p. (CONF-206-1)

For Presentation at Symposium on Carbides in Nuclear Energy Harwell, Eng., Nov. 1963.

Phase identification in the uranium–carbon system was accomplished by using data obtained by analyzing a series of high-purity as-cast and heat-treated specimens. The specimens were characterized by chemical analyses for uranium, total carbon, free carbon, oxygen, nitrogen, and tungsten; by x-ray diffraction; by metallographic examination; and by the gases evolved on hydrolysis. On hydrolysis, uranium monocarbide yielded predominantly methane; uranium metal (in U–UC alloys), hydrogen; uranium dicarbide, about 40 vol% hydrogen, 15 vol% methane, and 45 vol% C_2- to C_8-hydrocarbons; and uranium sesquicarbide, about 60 vol% hydrogen, 40 vol% C_2- to C_8-hydrocarbons, and virtually no methane. As-cast specimens with compositions between $UC_{0.4}$ and $UC_{1.0}$ (2 to 4.8 wt% C) were mixtures of uranium metal and uranium monocarbide (UC). Heat-treatments of UC specimens at temperatures between 1275 and 2000°C produced no effect, showing that uranium monocarbide is stable in this temperature range. In attempts to prepare $UC_{2.0}$, the maximum combined-C/U atom ratio obtained was 1.85 ± 0.03 (8.5 wt% C). Specimens with higher total-C/U atom ratios were binary mixtures of $UC_{1.85 \pm 0.03}$ and graphite. Heat-treating these specimens at temperatures between 1260 and 2000°C had no effect on their x-ray-diffraction patterns, hydrolysis products, or combined-C/U atom ratios. No uranium sesquicarbide was detected after heating for 60 hr at 1450°C or 240 hr at 1260°C; the oxygen and nitrogen concentrations of the specimens were less than 0.1 wt % and 0.01 wt %, respectively. Therefore, uranium dicarbide is a carbon deficient-compound of composition $UC_{1.85 \pm 0.03}$ which is thermally stable at least to short heat treatments at temperatures between 1260 and 2000°C. As-cast specimens and specimens heat treated above 1900°C with compositions between UC and $UC_{1.85}$ (4.8 to 8.5 wt % C) were mixtures of the monocarbide and dicarbide. Heat-treating $UC-UC_{1.85}$ specimens between 1275 and 1720°C resulted in the formation of two-phase structures between 1275 and 1720°C resulted in the formation of two-phase structures containing either UC and U_2C_3 or $UC_{1.85}$ and U_2C_3, with corresponding changes in microstructures, x-ray-diffraction patterns, and hydrolysis products. No external stress was required to form the sesquicarbide. The sesquicarbide decomposed into monocarbide and dicarbide when heated to 1900°C. These results obtained by heat treating $UC_{1.5}$ compositions are in agreement with those of other workers who found that U_2C_3 decomposed at about 1780°C. (auth)

37171 (TID-17733) THERMAL DECOMPOSITION OF URANYL NITRATE HEXAHYDRATE. R. S. Ondrejcin (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [Jan. 1963]. Contract AT(07-2)-1. 15p.

The thermal decomposition of uranyl nitrate hexahydrate was studied in the temperature range of 250 to 400°C at atmospheric and at <0.1 mm pressure. The intermediate and final products of the decomposition were determined. The decomposition follows a zero-order reaction until less than half of the uranyl nitrate remains. The remaining portion of the decomposition does not follow any simple kinetic interpretation. (auth)

37172 (UCRL-6744) THERMOCHEMISTRY OF THE BERYLLIA–WATER REACTION. Robert L. Altman (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 6, 1962. Contract W-7405-eng-48. 20p.

A third-law calculation of the heat of reaction for $BeO\ (s) + H_2O\ (s) \rightarrow Be(OH)_2\ (g)$ with a nonlinear model for $Be(OH)_2$ showed that a value of about 40 kcal/mole can be derived from the experimental data on this system. Heats of formation of the beryllium aluminates were also obtained. (auth)

37173 (UCRL-7022) THE CRYSTAL STRUCTURE AND POLARITY OF BERYLLIUM OXIDE. Deane K. Smith, Herbert W. Newkirk, and J. S. Kahn (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 4, 1962. Contract W-7405-eng-48. 45p.

X-ray intensity data from synthetic beryllium oxide crystals verified the distorted wurtzite-type structure previously reported by Jeffrey, Parry, and Mozzi. The oxygen z parameter obtained from the refinement was

0.3786 ± 0.0005 compared to 0.375 for the undistorted structure. The resulting structure has a Be–O bond distance of 1.659 ± 0.003 Å parallel to the c-axis and three distances of 1.645 ± 0.003 Å completing the tetrahedral coordination. The difference of 0.014 Å appears statistically significant and indicates that the long bond has slightly more ionic character than the other three. Measurement of the signs of the piezoelectric and pyroelectric charge and the shape and rate of etch pit formation were correlated with the internal crystal structure to identify the crystallographic polarity. On crystals showing a hemimorphic habit, consisting principally of a hemipyramid, a prism and a dominant pedion, the dominant pedion was shown to be terminated by oxygen atoms. In oxidizing etching media the $\{00.\bar{1}\}$ surfaces are much more reactive than the $\{00.1\}$ surfaces. The differences in surface reactivity are consistent with a modified version of the Warekois-Gatos hybrid orbital bonding model for $A_{III}-B_V$ and $A_{II}-B_{VI}$ compounds. A discussion is presented relating the crystalline structure of beryllium oxide to its mechanical properties and mechanism of crystal growth. (auth)

37174 (UCRL-7044) AN INVESTIGATION OF THE THERMAL STABILITY OF $MgUO_4$ UNDER HIGH OXYGEN PRESSURE. Robert L. Altman (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 6, 1962. Contract W-7405-eng-48. 18p.

$MgUO_4$, when heated in air at 1285°C, converts to a fluorite phase of apparent formula, MgU_3O_8. Infrared investigation of the solid phases indicated that the UO_2^{2+} ion present in $MgUO_4$ is not present in MgU_3O_8. If the oxygen pressure is increased to 15 atm, the orthorhombic $MgUO_4$ phase is stable up to at least 1450°C. An enthalpy of disproportionation for the reaction, $3MgUO_4\ (s) \rightarrow MgU_3O_8\ (s) + 2MgO\ (s) + O_2\ (g)$ of about 60 kcal/mole was obtained by a third-law treatment of the experimental data. (auth)

37175 (URS-74) INFRARED SPECTRA OF HIGHLY ASSOCIATED LIQUIDS AND THE QUESTION OF COMPLEX IONS IN FUSED SALTS. J. K. Wilmshurst (Union Carbide Corp. Parma Research Lab., Ohio). [1962]. 40p.

Infrared absorption spectra were derived from infrared reflectivity data by the method of Robinson and Price for the systems $LiNO_3-NaNO_3$, KNO_3-AgNO_3, $LiNO_3-LiOH$, $LiNO_3-H_2O$, $LiClO_3-H_2O$, $LiOH-NaOH$, $ZnCl_2-LiCl$, $ZnCl_2-KCl$, $CuCl_2-LiCl$, $CuCl_2-KCl$, and $CuCl-LiCl$. The question of the determination of the existence and nature of complex ions and ion pairs in these strongly associated systems is critically discussed and operational criteria are suggested. In only one system studied ($CuCl_2$–KCl) was the presence of a complex ion indicated by the spectroscopic data. (auth)

37176 (EURAEC-670) USE OF PLUTONIUM AS A FUEL IN NUCLEAR REACTORS. Quarterly Report No. 10, January 1, 1963–March 31, 1963. (Société Belge pour l'Industrie Nucléaire, Brussels). May 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 096-62-12RDB. 57p. A Translation. (BN-6305-02)

The development of PuO_2, UO_2, and mixed PuO_2-UO_2 fuel elements is reviewed. The procedures for preparing these fuels (e.g., calcination, sintering, and precipitation) are analyzed. Analytic methods (principally coulometric) developed for analysis of the process and the products are outlined. Separation methods (principally ion-exchange) are outlined for separation of U from Pu, separation of Pu from wastes, etc. (T.F.H.)

37177 OPTICAL MASER CHARACTERISTICS OF RARE-EARTH IONS IN CRYSTALS. L. F. Johnson (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 34: 897-909(Apr. 1963).

Several divalent and trivalent rare-earth ions incorporated in various host crystals were found to exhibit stimulated emission in the near infrared. The basic characteristics of these materials are presented: absorption and fluorescence spectra, energy level diagrams, optical maser wavelengths and operating temperatures, and thresholds for stimulated emission. Recent observations on the $CaWO_4:Nd^{3+}$ optical maser in continuous operation are also described. (auth)

37178 CHEMICAL SPUTTERING OF TUNGSTEN AT ELEVATED TEMPERATURES. H. F. Winters, D. R. Denison, D. G. Bills, and E. E. Donaldson (Washington State Univ., Pullman). J. Appl. Phys., 34: 1810-16(June 1963).

Positive ions emitted from heated tungsten filaments operating in various gas environments and in residual gases remaining at 10^{-11} Torr were investigated. The ions appear both as a continuous current and in the form of ion bursts. The pressure and temperature dependence of the ion current is given; the properties of the bursts are investigated; and a model for the mechanism of burst production is proposed. It is shown that the ion current can be used as a sensitive indicator of surface reactions. (auth)

37179 PRODUCTION OF HIGH-PURITY Li^7F CRYSTALS. C. F. Weaver, R. G. Ross, and R. E. Thoma (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 34: 1827-8 (June 1963)

The crucial points of purification and crystallization techniques used in the production of chemically pure Li^7F crystals are presented. (C.E.S.)

37180 SOME DIELECTRIC AND OPTICAL PROPERTIES OF KD_2PO_4. T. R. Sliker and S. R. Burlage (Clevite Corp., Cleveland). J. Appl. Phys., 34: 1837-40(July 1963).

The Curie point of KD_2PO_4 is found to be 222 ± 1°K, which is 9°K higher than previously reported. It is believed that the higher value is due to more complete deuteration. Other physical properties (at room temperature unless otherwise noted) are as follows: dielectric constant from 208 to 300°K; contour shear-mode resonance-frequency constant from 270 to 320°K; elastic compliance, $s_{66}^E = 165 \pm 3 \times 10^{-12}$ m²/N; piezoelectric constant, $d_{36} = 58 \pm 2 \times 10^{-12}$ C/N; electromechanical coupling $k_{36} = 0.22 \pm 0.01$; optical absorption between 200 and 2600 mμ for both KD_2PO_4 and KH_2PO_4 (the transmission of a 7.4-mm-thick KD_2PO_4 sample was greater than 50 percent from 400 to 1850 mμ); zero stress electro-optic coefficient, $r_{63} = 26.4 \pm 0.7 \times 10^{-12}$ m/V; lattice constants for both KD_2PO_4 and KH_2PO_4; and spontaneous polarization and coercive field from 150 to 222°K. (auth)

37181 ELECTROLYTIC CONDUCTION IN CALCIUM-DOPED SOLID CERIUM OXIDE. C. J. Kevane, E. L. Holverson, and Robert D. Watson (Arizona State Univ., Tempe). J. Appl. Phys., 34: 2083-7(July 1963).

At 460°C the passage of direct current through ceramic pellets of cerium dioxide containing one weight percent calcium oxide caused distinct volume discolorations to appear. The current at constant applied bias increased gradually from its initial value during the formation of the discolored regions, finally reaching a new, stable, higher level if sufficient time elapsed. In the latter case, both

anode and cathode surfaces were discolored and the discoloration extended completely through the body of a pellet. When insufficient time was allowed for the current to reach a new, stable level, only the cathode surface was discolored and the discoloration extended only part way through the material. The discolorations could always be removed by heating the pellets for one hour in air at 600°C and the entire process could be repeated many times. These effects are interpreted to indicate that a significant fraction of the current in this material at this temperature is carried by oxygen ions that move to the anode where they are plated-out leaving reduced, discolored material. (auth)

37182 OXYGEN DIFFUSION AND VAPORIZATION RATES FOR LIQUID AND SOLID GERMANIUM DIOXIDE. T. Tokuda and W. D. Kingery (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 34: 2104-5(July 1963).

The rate of exchange with oxygen enriched to 3% O^{18} was determined at a gas pressure of 150 mm Hg for polycrystalline hexagonal GeO_2. Results indicated that the exchange followed kinetics expected for a diffusion-controlled process. In liquid GeO_2 the oxygen exchange rate was found to be proportional to the square root of the time. The vaporization rates are such that a major mechanism of O^{18} depletion from the gas phase at temperatures above 1200°C is exchange at the surface followed by evaporation. The oxygen diffusion coefficients were calculated. (C.E.S.)

37183 HEATS AND FREE ENERGIES OF FORMATION OF THE ALKALI ALUMINUM HYDRIDES AND OF CESIUM HYDRIDE. HEAT OF FORMATION OF ALUMINUM CHLORIDE IN HYDROCHLORIC ACID. Martin B. Smith and George E. Bass, Jr. (Ethyl Corp., Baton Rouge, La.). J. Chem. Eng. Data, 8: 342-6(July 1963).

Standard heats of formation of five metal hydrides were determined by measuring their heats of reaction with HCl. The following values are reported for ΔH_f^0 (25°C) in kcal/mole: $LiAlH_4$(c), −28.4; $NaAlH_4$(c), −27.0; $KAlH_4$(c), −39.8; $CsAlH_4$(c), −39.4; and CsH(c), −11.92. Free energies of formation were also calculated. Thermodynamic stabilities of the alkali aluminum hydrides are discussed. The heat of formation of aluminum chloride in HCl was determined for the HCl molality range 0 to 4.6 and for $H_2O/AlCl_3$ mole ratios ranging from 200 to 500. (auth)

37184 HEAT CONTENT AND ENTROPY OF STRONTIUM CHLORIDE FROM 298° TO 1200°K. A. S. Dworkin and M. A. Bredig (Oak Ridge National Lab., Tenn.). J. Chem. Eng. Data, 8: 416-17(July 1963).

The heat content and entropy of $SrCl_2$ from 298 to 1200°K were measured by means of a copper block drop calorimeter. The following equations for the heat content (cal $mole^{-1}$) were obtained: $H_T - H_{298.15} = -4875 + 15.28T + 4.045 \times 10^{-3}T^2$ (298° to 940°K); $H_T - H_{298.15} = -12{,}430 + 28.53T$ (1040 to 1146°K); $\Delta H_{(fusion)} = 3850$ (1146°K); and $H_T - H_{298.51} = -7070 + 27.22T$ (1146 to 1205°K). A second order transition was found between the temperatures of about 940 and 1040°K. (auth)

37185 VAPOR PRESSURES OF YTTRIUM AND RARE EARTH CHLORIDES ABOVE THEIR MELTING POINTS. John L. Moriarty (Lunex Co., Pleasant Valley, Iowa). J. Chem. Eng. Data, 8: 422-4(July 1963).

The Knudsen molecular effusion method was used to determine the vapor pressures of the following chlorides above their melting points: YCl_3, $LaCl_3$, $CeCl_3$, $PrCl_3$, $NdCl_3$, $SmCl_2$, $EuCl_3$, $GdCl_3$, $TbCl_3$, $DyCl_3$, $HoCl_3$, $ErCl_3$, $TmCl_3$, $YbCl_3$, and $LuCl_3$. Heats of vaporization were calculated for each salt from linear plots of $\log_{10}$ P vs 1/T, using the Clausius-Clapeyron relationship. (auth)

37186 DENSITIES OF SOME MOLTEN ALKALI NITRATE AND SULPHATE MIXTURES. D. W. James (Oak Ridge National Lab., Tenn.) and C. H. Liu. J. Chem. Eng. Data, 8: 469(July 1963).

The densities of several molten nitrate systems were studied by the buoyancy method. For the system $LiNO_3-CsNO_3$, pure $CsNO_3$ and three mixtures were studied; for the system $NaNO_3-RbNO_3$, pure $RbNO_3$ and four mixtures were studied; for the system $NaNO_3-KNO_3$ the equimolar mixture, and for the system $Li_2SO_4-K_2SO_4$ the eutectic mixture was studied. All systems were studied over a range of temperatures and the data fitted to equations of the form $\rho = \alpha - \beta t$ by a least squares analysis. (auth)

37187 DEUTERON MAGNETIC RESONANCE STUDY OF BARIUM CHLORATE MONOHYDRATE. Takehiko Chiba (Tokyo Univ.). J. Chem. Phys., 39: 947-53(Aug. 15, 1963).

Quadrupole splitting of deuteron magnetic resonance was measured for a single crystal of $Ba(ClO_3)_2 \cdot D_2O$. Quadrupole coupling, asymmetry parameter, and principal axis directions of the field gradient tensor were determined at 20 and at −130°C eqQ/h = 121.5 ± 0.4 kc/sec, η = 0.976 ± 0.007 at 20°C, and eqQ/h = 243.5 ± kc/sec, η = 0.074 ± 0.002 at −130°C. The field gradient at room temperature shows a rapid reorientation of the water molecule in a crystal. At room temperature, the spectral line exhibits fine structure due to coupling of two spins, which was utilized to determine the sign of eqQ in the present case. The line broadening effect in the intermediate temperature region (−45 ~ −121°C) was measured and was used to obtain the reorientation rate at various temperatures. The barrier to reorientation of 6.6 kcal/mole was obtained from the comparison of the experimentally determined reorientation rate with that calculated from a tunneling process through a hindering barrier, or that of 6.5 kcal/mole from classical process. The temperature dependence of quadrupole splitting was also measured and the oscillation frequencies were derived for the torsional motion of D_2O. It was found that the quadrupole coupling for a vibrationless molecule is about 12% less than that of a free molecule. The observed eqQ, principal axis directions of field-gradient tensor are discussed in connection with the disposition of atoms in the crystal. A qualitative explanation is given for the change of eqQ from a free molecule to that in the crystal as due to the effect of the hydrogen-bonded oxygen atom. (auth)

37188 ABSORPTION AND FLUORESCENCE SPECTRA OF $Er^{3+}(4f^{11})$ IN LaF_3. William F. Krupke (Aerospace Corp., El Segundo, Calif.) and John B. Gruber. J. Chem. Phys., 39: 1024-30(Aug. 15, 1963).

The absorption, fluorescence, and excitation spectra of $Er^{3+}(4f^{11})$ in LaF_3 were investigated between 3500 and 10,000 Å. Based on an energy-level scheme consistent with all observed spectral lines, a number of states were identified. The parameters giving the best over-all agreement between the predicted free-ion spectrum and the spectrum of Er^{3+} in LaF_3 are F_2 = 428.708, F_4 = 67.784, F_6 = 6.751, and ζ = 2389.60 cm^{-1}. The average deviation for 11 of the levels is 35.3 cm^{-1}. The possible use of Er^{3+} in LaF_3 for the generation of coherent green light is also discussed. (auth)

37189 ELECTRON TRANSFER IN DILUTE GOLD ALLOYS. P. H. Barrett, R. W. Grant, Morton Kaplan, D. A. Keller, and D. A. Shirley (Univ. of California, Berkeley). J. Chem. Phys., 39: 1035-40(Aug. 15, 1963). (UCRL-10608)

Isomeric chemical shifts were observed in the Mössbauer spectra of Au^{197} atoms in dilute solutions in 19 metals and semiconductors at 4.2°K. The shifts were interpreted as arising from transfer of (conduction) electrons in the 6s shell of gold, probably toward the gold atom, in the alloys. A correlation was found between the shifts and the host electronegativities. The relationship between the 6s electron of gold and the nickel d bands in gold-nickel alloys is discussed. It is shown that the ground and first excited nuclear states of Au^{197} have radial charge moments sufficiently different (the excited state is probably larger) to require collective nuclear excitation. The isomeric shift in Al_2Au does not directly confirm the electroneutrality hypothesis for intermetallic compounds. (auth)

37190 ISOTOPIC EXCHANGE EFFECTS IN THE EVAPORATION OF WATER. I. LOW-TEMPERATURE EXPERIMENTAL RESULTS. H. Craig, L. I. Gordon, and Y. Horibe (Scripps Institution of Oceanography, La Jolla, Calif.). J. Geophys. Res., 68: 5079-87(Sept. 1, 1963).

The deuterium and O^{18} concentrations of water evaporating into air of nonzero humidity do not follow the simple batch distillation equation but increase asymptotically to a stationary isotopic state as the mass of water decreases to zero. This effect is due to a rapid molecular exchange between liquid and vapor, which predominates over the simple separation effect of removal of vapor. In dry air the batch distillation law is obeyed, and the isotopic enrichment continually increases; however, the separation factor is larger than the equilibrium isotopic vapor pressure ratio when the evaporation rate is comparable to natural rates. The HDO and H_2O^{18} enrichments in these experiments show a linear correlation with a slope of about 5.5, as found in the evaporation of natural water bodies. (auth)

37191 ON THE SPECTRUM OF TRIPOSITIVE NEPTUNIUM IN SINGLE CRYSTALS OF LANTHANUM TRICHLORIDE. J. B. Gruber (Univ. of California, Los Angeles). J. Inorg. Nucl. Chem., 25: 1093-5(Sept. 1963). (In English)

The absorption and fluorescence spectra of $Np^{3+}(5f^4)$ in $LaCl_3$ were studied. Results indicated that fluorescence takes place from several Stark-component levels in the near ultraviolet and visible regions of the spectrum. A comparison was made between the theoretical "free-ion" spectrum of $Np^{3+}(5f^4)$ with the observed spectrum of Np^{3+} in $LaCl_3$. (M.C.G.)

37192 CO-ORDINATION COMPLEXES OF NIOBIUM AND TANTALUM. I. COMPLEX FORMATION OF NIOBIUM AND TANTALUM PENTAHALIDES AND NIOBIUM(V) OXYCHLORIDE WITH ACETYLACETONE IN ALCOHOL SOLUTIONS AND FORMATION OF OXO-DICHLORO-ACETYLACETONATO NIOBIUM(V). C. Djordjević and V. Katović (Univ. of Zagreb and Rudjer Boskovic Inst., Zagreb). J. Inorg. Nucl. Chem., 25: 1099-1109(Sept. 1963). (In English)

Complexes of the type $MX_2AcAc(OR)_2$, where M = Nb(V), Ta(V); X = Cl,Br; AcAc = acetylacetone; and R = CH_3, C_2H_5 were prepared from the metal pentahalides and acetylacetone in the parent alcoholic solutions. They are stable crystalline substances, but in solutions in alcohols interactions with solvent molecules occur, as is evident from conductivity and molecular weight studies. Powder x-ray diffraction photographs showed that the methoxo chloro and bromo derivatives of niobium and tantalum are isomorphous and that the analogous ethoxo complexes form another isomorphous group. Infrared spectra were analyzed and a tentative assignment of some characteristic vibrational modes is given. Metal-ligand vibrational modes appear at frequencies close to those in other metal acetylacetonates and metal alkoxides. Under similar experimental conditions, starting from $NbOCl_3$ and acetylacetone in methyl and ethyl alcohol solutions, complex derivatives of the same type, $NbCl_2AcAc(OR)_2$, were isolated. These results imply the unexpected solvolysis of the niobium-oxygen bond in alcohol solutions. A compound of the formula $[NbOCl_2AcAc]_x$ was isolated from the reaction of $NbOCl_3$ with acetylacetone. Infrared spectrum of this oxo-dichloro-acetylacetonato-niobium (V) revealed the presence of co-ordinated acetylacetone and the vibrational modes of the niobium-oxygen double bond. Deuteration studies permitted the assignment of some bands. (auth)

37193 THERMAL DECOMPOSITION OF YTTRIUM OXALATE IN VACUUM AND IN VARIOUS ATMOSPHERES. A. Glasner, E. Levy, and M. Steinberg (Hebrew Univ., Jerusalem). J. Inorg. Nucl. Chem., 25: 1119-27 (Sept. 1963). (In English)

Yttrium oxalate may be dehydrated in vacuum at a temperature as low as 260°, and decomposition of the oxalate itself begins upon completion of dehydration. In vacuum as well as in an open furnace, various carbonato-oxalates and oxycarbonates are formed in the temperature range 300 to 420°. Disproportionation of the carbon monoxide originating from the initial decomposition of the oxalate takes place to an extent of nearly 60%. The carbon thus deposited stabilizes the oxycarbonate and CO and CO_2 are evolved only on heating at 700 to 1000°. In an oxidizing atmosphere the carbon is burned away, and white Y_2O_3 may be obtained at 420° under proper conditions. (auth)

37194 HIGH PRESSURE REACTIONS OF CaO AND CdO WITH URANIUM OXIDE. A. P. Young and C. M. Schwartz (Battelle Memorial Inst., Columbus, Ohio). J. Inorg. Nucl. Chem., 25: 1133-7(Sept. 1963). (In English)

Mixtures of uranium oxide and bivalent metal oxides were reacted at 60,000 atm and 900 to 1200°C. CaU_3O_{9+x} compounds with Cu_3Au-type ordering of uranium and calcium ions were synthesized at high pressure. Ordering was dependent on oxygen content. High-pressure compounds with compositions CaU_3O_9 and $CaU_3O_{8.9}$ were ordered. High-pressure compounds with compositions $CaU_3O_{8.6}$, $CaU_3O_{8.4}$, and $CaU_3O_{7.75}$ were face-centred cubic. The dependence of ordering on oxygen content can be explained qualitatively if oxygen is assumed to go into cell centres in a CaU_3O_{8+x} fluorite-type structure. No superlattice reflections indicative of ordering of U and Cd ions were observed in high pressure CdU_3O_9. High pressure $CaUO_3$ was face-centred cubic. (auth)

37195 DEVELOPMENT OF A METHOD FOR MEASURING IONIC SELF-DIFFUSION. Guy F. Allen, Helmut Schurig, Laird Slade, and Henry C. Thomas (Univ. of North Carolina, Chapel Hill). J. Phys. Chem., 67: 1402-7(July 1963).

Self-diffusion coefficients of ions traceable by γ-ray emitters can be deduced from determinations of the total activity of a short rod of the material from which the diffusion takes place through a thin membrane into a rapidly stirred bath at zero activity. Earlier work with the method was inadequate both theoretically and experimentally. Mathematical and experimental developments are described, which enable an assessment of the accuracy of the results for self-diffusion in gels. Results for sodium, cesium, and cobalt(II) (as chlorides) at various concentrations are reported. (auth)

37196 RARE EARTH OXIDE SYSTEMS. THE HYSTERESIS EFFECTS IN PRASEODYMIUM OXIDE. Paul A. Faeth and Alan F. Clifford (Purdue Univ., Lafayette, Ind.). J. Phys. Chem., 67: 1453-7(July 1963).

The composition–pressure diagram of the Pr–O system was studied between 10^{-5} and 150 mm oxygen pressure using a quartz beam microbalance. The isotherms between 400 and 500° show hysteresis between $PrO_{1.80}$ and $PrO_{1.83}$ as the pressure varies. At 465° a hysteresis loop extends over the entire pressure range. Everett's theory of hysteresis is compared to the Pr–O isotherms at 465°. The seven theorems proposed by Everett are cited and discussed with reference to the Pr–O data. In general, the agreement between the properties of Everett's theoretical model of a domain system and the properties of the Pr–O system is good. Results of a preliminary study of the region between loop boundaries indicate that more than two domain states are present. The behavior of the praseodymium oxide system is thought to be a result of its being composed of domains of various stable compositions, such as $PrO_{1.83}$ and $PrO_{1.80}$. The domains change composition as a function of the oxygen pressure. (auth)

37197 THE THEORY OF ELECTRON SCATTERING FROM MOLECULES. I. THEORETICAL DEVELOPMENT. T. Iijima, R. A. Bonham, and T. Ando (Indiana Univ., Bloomington, Ind.). J. Phys. Chem., 67: 1472-4(July 1963).

The quantum theory of electron scattering from molecules in the gas phase was developed. Expressions that include the effects of chemical binding are presented and the intensity averages to be expected for various types of experiments are discussed in terms of the theory. The quantum mechanical average over the rotational states of the molecule is shown to be reducible to the classical method of averaging rotational motion except in the case of extremely high energy resolution of the scattered electrons. (auth)

37198 THE ENTHALPIES OF FORMATION OF ZIRCONIUM DIHYDRIDE AND ZIRCONIUM DIDEUTERIDE. Donald R. Fredrickson, Ralph L. Nuttall, Howard E. Flotow, and Ward N. Hubbard (Argonne National Lab., Ill.). J. Phys. Chem., 67: 1506-9(July 1963). (TID-18172; UAC-7146)

The standard energies of combustion of ZrH_2 and ZrD_2 were determined by precision oxygen bomb calorimetry. The values found for ΔE_c^0 were -290.03 ± 0.24 kcal mole^{-1} of ZrH_2 and -290.80 ± 0.18 kcal mole^{-1} of ZrD_2. At 298.15°K the enthalpy of formation, ΔH_f^0, and the Gibbs energy of formation, ΔG_f^0, were calculated to be -38.90 ± 0.31 kcal mole^{-1} and -29.32 ± 0.31 kcal mole^{-1}, respectively, for ZrH_2, and -40.22 ± 0.27 kcal mole^{-1} and -29.86 ± 0.27 kcal mole^{-1}, respectively, for ZrD_2. (auth)

37199 FURTHER STUDIES ON THE MASS SPECTRA OF BUTANOLS. 3-MONODEUTERIO-1-BUTANOL AND 4-MONODEUTERIO-1-BUTANOL. W. H. McFadden, D. R. Black, and J. W. Corse (Western Regional Research Lab., Albany, Calif.). J. Phys. Chem., 67: 1517-19(July 1963).

The mass spectra of 1-butanols labeled in the 3- and 4-positions were obtained in order to extend the existing knowledge of the fragmentation characteristics of alcohols. It is shown that transfer of a hydrogen leading to the rearrangement in which H_2O is lost and the $C_4H_8^+$ ion is formed is specific to the hydrogens on position 4. The rearrangement ion $CH_3OH_2^+$ is apparently formed by statistically selecting two hydrogens from those on carbons 2, 3, and 4. The hydrogens present on carbon 1 show only a modest tendency to exchange with the others. (auth)

37200 THE IONIZATION POTENTIALS OF MONOSUBSTITUTED PYRIDINES BY ELECTRON IMPACT. Michael R. Basila and Donald J. Clancy (Gulf Research and Development Co., Pittsburgh). J. Phys. Chem., 67: 1551-4(July 1963).

The electron impact ionization potentials of a number of monosubstituted pyridines were determined by the same technique and on the identical instrument used previously for mono- and disubstituted benzenes. The combined sets of data provide a self-consistent set for the comparison of substituent effects. Linear relationships are shown to exist between the ionization potentials of the 4-substituted pyridines and the monosubstituted benzenes of para-substituted toluenes. Consideration of the linear relationships leads to the suggestion that the electron impact ionization potentials primarily correspond to the removal of a π-electron, and that the substituent effects upon the pyridine π-electrons parallel those upon the benzene or toluene π-electrons, with the heterocyclic nitrogen atom introducing an almost constant perturbation. (auth)

37201 PREPARATION AND STUDY OF ORDERING IN $A(B'_{0.33}Nb_{0.67})O_3$ PEROVSKITE-TYPE COMPOUNDS. Francis Galasso and Jane Pyle (United Aircraft Corp., East Hartford Conn.). J. Phys. Chem., 67: 1561-2(July 1963).

A study of ordering was undertaken in an analogous series produced of perovskite-type compounds produced by substituting Nb for Ta in the $A(B'_{0.33}Ta_{0.67})O_3$ compounds. The most interesting difference found between the $A(B'_{0.33}Nb_{0.67})O_3$ and $A(B'_{0.33}Ta_{0.67})O_3$ was the fact that the B ions were ordered in $Ba(Zn_{0.33}Ta_{0.67})O_3$ and $Ba(NI_{0.33}Ta_{0.67})O_3$, but no evidence of ordering was found in the $Ba(Zn_{0.33}Nb_{0.67})O_3$ and $Ba(Ni_{0.33}Nb_{0.67})O_3$ x-ray patterns even though the size and charge of Ta and Nb ions are similar. It was noted that the size and charge difference of the B ions appear to be the most important causes of their ordering in the compounds, and it is only when their effect is minimized that other factors become most influential in producing an ordered arrangement of B ions. (P.C.H.)

37202 ISOTOPIC FRACTIONATION IN THE $OH^- - H_2O$ EXCHANGE REACTION. Michael Green and Henry Taube (Univ. of Chicago). J. Phys. Chem., 67: 1565-6(July 1963).

A direct experiment was performed to measure the equilibrium constant in the system $H_2O^{16}_{liq} + O^{18}H^-_{aq} \rightleftharpoons H_2O^{18}_{liq} + O^{16}H^-_{aq}$, which was found to be 1.045 ± 0.003 at 15°C. The value seems to be compatible with both experimental and theoretical data. (P.C.H.)

37203 CATIONIC MOBILITIES IN FUSED CESIUM NITRATE AND THALLOUS NITRATE. S. Forcheri and C. Monfrini (CCR Euratom, Ispra, Italy). J. Phys. Chem., 67: 1566(July 1963).

The experimental technique of electrophoresis on thin layers was used for the determination of single ionic mobilities in molten salts. The technique is described. The results were found to be 1.63 ± 0.07 and 1.05 ± 0.06 for $CsNO_3$ at 450°C and $TlNO_3$ at 250°C, respectively. (P.C.H.)

37204 THE MAGNETIC SUSCEPTIBILITY OF PROMETHIUM-147 OXIDE. J. C. Sheppard, E. J. Wheelwright, and F. P. Roberts (General Electric Co., Richland, Wash.). J. Phys. Chem., 67: 1568-9(July 1963). (HW-SA-2893)

At 25°C $Pm_2^{147}O_3$ was found by the Gouy technique to have a specific susceptibility of 15.5×10^{-6} cgs unit. After making an allowance for the diamagnetic contribution in the compound Pm_2O_3, the molar susceptibility was calcu-

lated to be 2660×10^{-6} cgs unit. Assuming that the ground state of Pm^3 is $^5I_4$ and that the multiplet intervals are large compared to kT, a molar susceptibility of 2960×10^{-6} cgs unit was calculated. The values were found to be in reasonable agreement. (P.C.H.)

37205 THE CRYSTAL STRUCTURE OF THE MOLECULAR ADDITION COMPOUND XENON DIFLUORIDE–XENON TETRAFLUORIDE. J. H. Burns, R. D. Ellison, and H. A. Levy (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 1569-70(July 1963).

Diffraction intensities from a single crystal of $XeF_2 \cdot XeF_4$ were measured, and a total of 574 independent reflections was recorded, which included virtually all having detectable intensity. The approximate shape of the crystal was determined, making it possible to calculate an absorption correction for each reflection. The mean diameter of the crystal was about 0.015 cm; the value of the absorption coefficient used was 119.5 cm^{-1}. A trial structure (and the formula) was determined by the Fourier synthesis method. Molecular patterns were also found for the crystal. The hypothesis that the XeF_4 molecule is square-planar was found to be consistent with the study, and the individual molecular geometries are retained in the compound with very little change. There also was no structural evidence for the formation of any strong bonds between molecules, and the phase appears to be appropriately described as a molecular addition compound. (P.C.H.)

37206 THE VAPOR PRESSURE OF SCANDIUM METAL. Oscar H. Krikorian (Univ. of California, Livermore). J. Phys. Chem., 67: 1586-9(Aug. 1963). (UCRL-7136)

The vapor pressure of Sc metal was measured by the Knudsen effusion technique at temperatures of 1200 to 1570°. Its enthalpy of sublimation at 298°K was found to be 91.2 ± 0.3 kcal/g-atom from a third-law treatment, and 91.1 ± 1.6 kcal/g-atom from a second-law treatment of the data. High-temperature thermodynamic functions of Sc metal were estimated. (auth)

37207 THE ENERGY DEPENDENCE FOR REACTION CROSS SECTIONS OF ION-MOLECULE REACTIONS OF SOME PENTYL AND CYCLOPENTYL HALIDES. Andrée J. Lorquet and William H. Hamill (Univ. of Notre Dame, Ind.). J. Phys. Chem., 67: 1709-12(Aug. 1963).

Ion-molecule reactions of cyclopentyl chloride, bromide, and iodide, 3-bromopentane, and 1-iodopentane were observed in a mass spectrometer. Primary and secondary ion appearance potentials were measured. Several of the secondary ion abundance curves exhibit maxima or concealed maxima at electron energies approximating excited state levels of the corresponding primary methyl halide ions. The dependence of reaction cross sections for secondary ions upon repeller field was correlated with previous studies. (auth)

37208 THE HEAT OF FORMATION OF URANIUM DICARBIDE. Elmer J. Huber, Jr., Earl L. Head, and Charles E. Holley, Jr. (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 67: 1730-1(Aug. 1963).

An indirect experimental determination was made of the heat of formation of uranium dicarbide, $UC_{1.90}$, from measurements of its heat of combustion in oxygen. Calculated values of the heats of formation for three series of runs were –19.7 ± 2.0, –18.6 ± 1.9, and –21.1 ± 1.4 kcal/mole. The value $\Delta H_f = -21.1 \pm 1.4$ kcal/mole was taken for the heat of formation of $UC_{1.90}$. (P.C.H.)

37209 THE HEAT OF FORMATION OF SCANDIUM OXIDE. Elmer J. Huber, Jr., George C. Fitzgibbon, Earl L. Head, and Charles E. Holley, Jr. (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 67: 1731-3(Aug. 1963). (LADC-5693)

The heat of combustion of Sc metal corrected for impurities was calculated to be 5062.1 ± 5.6 cal/g. The heat of solution of Sc was measured in a solution of HCl, which contained a small amount of Na_2SiF_6. The average value for five experiments was 3350.7 ± 2.0 cal/g. The heat of formation of cubic Sc_2O_3 was calculated from the combustion results to be $\Delta H_f^0 = -456.16 \pm 0.50$ kcal/mole. From the heat of solution measurements the heat of formation of Sc_2O_3 was calculated to be –458.3 ± 0.7 kcal. (P.C.H.)

37210 THE THERMODYNAMIC AND PHYSICAL PROPERTIES OF BERYLLIUM COMPOUNDS. IV. HEAT AND ENTROPY OF SUBLIMATION OF BERYLLIUM CHLORIDE. Michael A. Greenbaum, Robert E. Yates, and Milton Farber (Rocket Power, Inc., Pasadena, Calif.). J. Phys. Chem., 67: 1802-5(Sept. 1963).

The vapor pressure curve of $BeCl_2$(s) was determined over the temperature range 440-600°K using Knudsen gravimetric and torsion effusion procedures. From analysis of the vapor pressure data, second-law values for the heat and entropy of sublimation of $BeCl_2$ are 32.9 ± 0.4 kcal/mole and 42.7 ± 1.4 cal/deg mole. By means of estimated thermal functions ΔH_{sub}^{298} was found to be 33.1 ± 0.5 kcal/mole and ΔS_{sub}^{298} was 43.2 ± 1.5 cal/deg mole. The corresponding third-law value for ΔH_{sub} is 32.1 kcal/mole. (auth)

37211 SPECTRA OF DILUTE SOLUTIONS OF BISMUTH METAL IN MOLTEN BISMUTH TRIHALIDES. II. FORMULATION OF SOLUTE EQUILIBRIUM IN BISMUTH TRICHLORIDE. Charles R. Boston (Oak Ridge National Lab., Tenn.), G. Pedro Smith, and Lester C. Howick. J. Phys. Chem., 67: 1849-52(Sept. 1963).

A procedure was devised for extracting from spectrophotometric data the concentration of the two solute species formed when metallic Bi is dissolved in molten $BiCl_3$. The functional relation between the concentrations was found to be in accord with a family of solute equilibria of which the simplest was $4Bi^+ = Bi_4^{4+}$. The equilibrium constant K_N was computed to have a value of 3.8×10^6 at 264°. This is within experimental error of the value, 2.7×10^6, obtained by a previous emf study. (auth)

37212 CONFIRMATION OF DEFECT CHARACTER IN CALCIUM FLUORIDE–YTTRIUM FLUORIDE CRYSTALLINE SOLUTIONS. James Short and Rustum Roy (Pennsylvania State Univ., University Park). J. Phys. Chem., 67: 1860-1(Sept. 1963).

Interstitial F^- is the predominant defect in crystalline solutions of YF_3 in CaF_2, according to a comparison of measured pycnometric densities with calculated x-ray densities over the range 0-40 mole % YF_3. The phase diagram of the system CaF_2–YF_3 was determined tentatively, and the influence of the defects is evident in the unusual maximum in the liquidus and a sharp drop in thermal stability near the solubility limit of 55 mole % YF_3. A new hexagonal phase with composition near $CaF_2 \cdot 4YF_3$ is described, with a = 6.77 and c = 6.98 Å. (auth)

37213 FREEZING POINT DEPRESSIONS IN SODIUM FLUORIDE. III. EFFECTS OF 3d TRANSITION METAL DIFLUORIDES AND CADMIUM FLUORIDE. Stanley Cantor and Wilfred T. Ward (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 1868-70(Sept. 1963).

Measurements were made of the freezing point depressions of NaF caused by the addition of up to 0.20 mole fraction MnF_2, FeF_2, CoF_2, NiF_2, CuF_2, ZnF_2, or CdF_2. The excess partial molal free energies of solution of NaF, $(\bar{F} - F^0)^E_{NaF}$, evaluated from the measurements, were all negative and approached zero asymptotically as the mole

fraction of NaF approached unity. At fixed concentration, the trend in $(\bar{F} - F^0)^{\underline{E}}_{NaF}$ with the atomic number of MnF_2, FeF_2, CoF_2, NiF_2, and ZnF_2 solutes was consistent with ligand field theory. This trend also suggested that these five 3d solute cations were octahedrally coordinated in NaF solution. The other 3d difluoride, CuF_2, decomposed at high temperature, thereby preventing experimental study of the effect of this solute on $(\bar{F} - F^0)^{\underline{E}}_{NaF}$. The effects of ZnF_2 in contrast to MgF_2, and of CdF_2 in contrast to CaF_2, were attributed to the differing polarizing powers of the solute cations. (auth)

37214 FLUORINE BOMB CALORIMETRY. VI. THE ENTHALPY OF FORMATION OF URANIUM HEXAFLUORIDE. Jack L. Settle, Harold M. Feder, and Ward N. Hubbard (Argonne National Lab., Ill.). J. Phys. Chem., 67: 1892-5(Sept. 1963).

The enthalpy of formation of uranium hexafluoride was measured by direct combination of the elements in a bomb calorimeter. $\Delta Hf^0_{298.15}$ (kcal mole^{-1}) = –522.64 ± 0.43 (crystal) and –510.77 ± 0.45 (gas). (auth)

37215 OBSERVATION OF A URANIUM(V) SPECIES IN MOLTEN CHLORIDE SALT SOLUTIONS. M. D. Adams, D. A. Wenz, and R. K. Steunenberg (Argonne National Lab., Ill.). J. Phys. Chem., 67: 1939-41(Sept. 1963).

Evidence to support the existence of a uranium(V) species, UO, was found in electrolytic reductions studies of UO_2Cl_2 in both aqueous and in molten salt solutions. A spectrum that could not be attributed to uranium(III), (IV), or (VI) species was obtained with a solution of $MgUO_4$ dissolved in $LiCl-MgCl_2$ at 650°C. The same spectrum was later obtained with a solution of UO_2Cl_2 in the same solvent and same temperature. Similar spectra then were observed in solutions produced by dissolving U_3O_8, UO_3, and UO_2Cl_2 in other salt mixtures. The spectrum was assigned to a U(V) species, which is believed to result from the equilibrium reaction $UO_2Cl_2 \rightleftharpoons UO_2Cl + \frac{1}{2}Cl_2$. Concentrated U(V) solutions were greenish yellow in color; dilute solutions yellow. As the solutions solidified, the color changed to black or gray depending on concentration. Other properties are also discussed. (P.C.H.)

37216 THE FORMAL REDUCTION POTENTIAL OF THE EUROPIUM(III)–EUROPIUM(II) SYSTEM. Larry B. Anderson and Daniel J. Macero (Syracuse Univ., N. Y.). J. Phys. Chem., 67: 1942(Sept. 1963).

A chronopotentiometric study with current reversal of 3×10^{-3} M Eu in the noncomplexing medium, 1M sodium perchlorate-perchloric acid (pH 2.08) at 25°C was carried out in order to estimate the true formal reduction potential. The formal reduction potential of the system was calculated from the relationship $E^0_f = RT/nF \ln (k^0_{f,H}/k^0_{b,H})$. On the basis of the results, the use of the value of –0.55 v vs Ag–AgCl–NaCl (satd) (–0.35 v vs nhe) is recommended for the formal reduction potential of the $Eu^{3+}-Eu^{2+}$ couple in noncomplexing medium. (P.C.H.)

37217 HIGH TEMPERATURE DEUTERATION OF CELLULOSE II. Saburo Okajima and Kimio Inoue (Tokyo Metropolitan Univ.). J. Polymer Sci., Pt. B, 1: 513-16 (Sept. 1963).

Cellulose II film was heat-treated with D_2O or H_2O at 170 to 220°C, and measurement was made of the amount of resistant OD groups, ΔX_{OD}, or the increment of the nonaccessible part to D_2O vapor of room temperature, X_{OH}. The data indicate that an increase in ΔX_{OD} follows a decrease in X_{OH} and the sum of ΔX_{OD} and X_{OH} is nearly constant and slightly larger than X_{OH} of the original film. The resistant OD groups show considerable resistance to rehydrogenation at room temperature, losing, however, much of their resistivity at higher temperatures. Deuteration and rehydrogenation seem to reach the crystalline region of cellulose II rather easily at such higher temperature. (P.C.H.)

37218 THE TRACE ELEMENT URANIUM AND ITS EFFECTS IN REDOX SYSTEMS. Alfons Krause, F. Domka, and I. Plura (Universität, Poznan, Poland). Naturwissenschaften, 50: 518(1963). (In German)

The catalytic effects of trace amounts of U, in the form of UO_2^{2+}, were studied with the peroxide Indigo Red bleaching reaction. Carriers of $MgCO_3$, $Ni(OH)_2$, $Co(OH)_2$, $Al(OH)_3$, and $Fe(OH)_3$ were tested. H_2O_2 solutions of Indigo Red were the substrates. The uranyl ion activated the bleaching reaction in the $Fe(OH)_3$ solutions but acted as an inhibitor in the other solutions. The extinction values measured are given in tabular form. The surface complexes formed as activators and inhibitors are discussed. (J.S.R.)

37219 ON THE THERMOCHEMICAL PROPERTIES OF URANIUM CARBIDES. Takashi Mukaibo and Keiji Naito (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 601-8(July 1963). (In English)

Measurements were made of specific heats on UC and UC_2 above room temperature, and the assessment of experimental thermochemical data became possible with some accuracy. The specific heat functions for UC and UC_2 were derived as a function of temperature, from which the heats of formation, free energies of formation, and entropies of formation of these carbides were also calculated as a function of temperature, respectively. It was found that measurements at high temperatures by several authors were fairly accurate with some scattering of data. (auth)

37220 ADSORPTION OF POLONIUM FROM SALT SOLUTIONS BY GLASS AND PAPER FILTERS. I. E. Starik, B. S. Kuznetsov, and N. I. Ampelogova. Radiokhimiya, 5: 304-10(1963). (In Russian)

Polonium sorption from aqueous solutions HCl, NaCl, $BaCl_2$, and $La(NO_3)_3$ by glass and paper filters was studied as a function of solution pH = 1 to 6. A maximum sorption by glass was observed at pH = 5 to 5.5 and for paper at pH = 2 to 3. With pH below 2 to 3 and an increased amount of $BaCl_2$ and $La(NO_3)_3$, the sorption becomes weaker. With pH > 3 and small amounts of barium or sodium chloride salts present the paper and glass sorption is enhanced. Additional $BaCl_2$ concentrations inhibit the sorption. Admixtures of lanthanum salts at pH = 3 to 6 do not affect sorption by glass but enhance Po sorption by paper. (R.V.J.)

37221 INFRARED ABSORPTION SPECTRA OF URANYL NITRATE AND ITS COMPLEXES WITH NEUTRAL ADMIXTURES. V. M. Vdovenko, D. N. Suglobov, and V. A. Krasilnikov. Radiokhimiya, 5: 311-19(1963). (In Russian)

Infrared spectra of uranyl nitrate and $UO_2(NO_3)_2 \cdot 2A$ complexes (A is a molecule of nitrogen dioxide, water, acetonitrile, methylethylketone, ethyl ether, or pyridine) were measured at the 650 to 1800 cm^{-1} region. The number and distribution of absorption bands revealed good coordination between admixture molecules and nitrate groups. A good nitrate group coincidence in spectra of various complexes indicate identical structure in coordinated uranium sphere. A partially covalent uranium–admixture bond was also found. Anharmonious uranyl valency oscillations in various compounds and the constant force in U–O bond and the constant interaction force of U–O bond in uranyl were determined. (R.V.J.)

37222 ADDITIONAL DATA ON SOLUBILITY OF TETRAVALENT URANIUM OXALATES. A. A. Grinberg and G. I. Petrzhak. Radiokhimiya, 5: 319-29(1963). (In Russian)

Studies of $U(C_2O_4) \cdot 6\ H_2O$ solubility in various concentrations of oxalic acid showed that solubility level increases with increased acid. A new method was developed for determining the content of U and of U(IV). Due to partial oxidation of U(IV) the solubility of $U(C_2O_4)_2 \cdot 6\ H_2O$ is not constant and depends on experimental conditions. The results confirm U(IV) oxalate acidity properties similar to those of oxalic acid. The influence of uranium oxalates on the kinetics of its transition into a solution and on the pH in the solution was observed. (R.V.J.)

37223 COMPLEX FORMATION OF PROTACTINIUM WITH MONO-, DI-, AND POLY CARBOXYLIC ACIDS BY ION EXCHANGE. II. COMPLEXING OF PROTACTINIUM WITH α-HYDROXYAZOBUTYRIC AND AMYGDALIC ACIDS. A. V. Lapitskii and I. Geletseanu. Radiokhimiya, 5: 330-4 (1963). (In Russian)

Distribution of Pa in complexing with α-hydroxyazobutyric and amygdalic acids with 0.001 to 0.5M concentrations and variable pH is a function of pH and concentrations of addends. Ageing reduces Pa adsorption on cation due to an increased radiolysis and colloidal formation. Complex formation of protactinium–α–hydroxy–azobutyric acid at given concentrations and pH = 1.1 follows two stages. Instability constants for protactinium–α–hydroxyazobutyric acid complexes $K_1 = 3.43 \times 10^{-4}$ and 3.36×10^{-4} and $K_2 = 1.5 \times 10^{-7}$ and 10^{-7} (Me : R = 1 : 2 and 1 : 3) respectively and for complexes with amygdalic acid $K_1 = 1.45 \times 10^{-3}$ and 1.17×10^{-3} (Me : Re = 1 : 1) respectively. (R.V.J.)

37224 ELECTROMIGRATION METHOD OF DETERMINING PHYSICO-CHEMICAL CONSTANTS OF MAXIMUM DILUTED COMPOUNDS. II. DETERMINATION OF PHYSICO-CHEMICAL PROPERTIES OF Tc AND Re COMPOUNDS. V. P. Shvedov and K. V. Kotegov. Radiokhimiya, 5: 374-8(1963). (In Russian)

Continuous electrophoresis on porous filler was used for determining the dissociation constants, equivalent electroconductivity, and dimensions of solvated ions in maximum dilute solutions. The mobility of TcO_4^- and ReO_4^- ions in infinite dilution was: $U^0_{TcO_4} = 53.0 \times 10^{-5}$ cm²/W · sec and $U^0_{ReO_4} = 48.4 \times 10^{-5}$ cm²/W · sec at 18° was determined. Dissociation constants were calculated for $KTcO_4$, $CsTcO_4$, $KReO_4$, and $CsReO_4$ which at 18°C correspond to 0.122, 0.231, 0.063, and 0.095. (R.V.J.)

37225 THE RADIAL DISTRIBUTION CURVES OF LIQUIDS BY DIFFRACTION METHODS. K. Furukawa (Birbeck Coll., London and Fulmer Research Inst. Ltd., Stoke Poges, Buckinghamshire, Eng.). Rept. Progr. Phys., 25: 395-440(1962).

The investigation of liquid structure by radial distribution analysis of diffraction patterns is reviewed. Formulas for obtaining the radial distribution function from electron, neutron, and x-ray scattering are given, and the apparatus and experimental methods are discussed. The procedure for processing experiments is also described. The individual radial distribution curves reported for monatomic, diatomic, and polyatomic liquids; liquid alloys; water and its aqueous solutions; ionic liquids; molten oxides; and glasses are reviewed. 217 references. (auth)

37226 KRYPTON DIFLUORIDE: PREPARATION AND HANDLING. D. R. MacKenzie (Brookhaven National Lab., Upton, N. Y.). Science, 141: 1171(Sept. 20, 1963).

Krypton difluoride was prepared by irradiation of krypton and fluorine in an electron beam (1.5 Mev) at −150°C. The compound is a white crystalline solid, stable only at temperatures below about −30°C. (auth)

37227 THE DIELECTRIC PROPERTIES OF SINGLE CRYSTALS OF CESIUM NITRATE. A. S. Sonin and I. S. Zheludev (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 219-21 (Sept.-Oct. 1963).

The dielectric properties of single crystals of cesium nitrate, which were grown from fusion, are studied. The $CsNO_3$ single crystals exhibit a perfect cleavage on the (0001) plane. Examination of the orientation of the crystal was carried out by Laue x-ray photography. In agreement with the symmetry of the $CsNO_3$ crystal, the dielectric constant was measured on plates cut normal to the threefold axis and parallel to it. (R.E.U.)

37228 DYNAMIC POLARIZATION OF PROTONS IN LANTHANUM–MAGNESIUM DINITRATES. V. I. Lushchikov, A. A. Manenkov, and Yu. V. Taran (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 5: 169-71(July 1963).

By saturating the forbidden transitions of Ce^{3+} ions in a single crystal of $(Ce, La)_2Mg_3(NO_3)_{12} \cdot 24H_2O$ in a field of 3700 Oe at a temperature of 1.6°K, polarization of protons was magnified 170 times in comparison with polarization at thermal equilibrium. The dependence of the nuclear spin-lattice relaxation time on temperature (in the range from 1.5 to 1.7°) and on the cerium concentration (in the range from 0.2 to 1.0%) was measured. (auth)

37229 EPR SPECTRA OF THE RADICALS HO_2 OH, DO_2 AND OD. S. D. Kaitmazov and A. M. Prokhorov (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 5: 251-3(July 1963).

Studies were made on the EPR spectrum of radicals obtained by gamma irradiation of frozen H_2O_2. The spectrum of radicals obtained from H_2O_2 was compared with the EPR spectrum of radicals obtained by irradiation of D_2O_2. The spectrum of DO_2 radical obtained at high concentrations differs from the spectrum of HO_2 by the absence of the 12 Oe doublet characteristic of HO_2. In the EPR spectrum obtained on irradiation of dilute D_2O_2, instead of the 45 Oe doublet, a triplet with a total splitting of 15 Oe was observed on the strong-field side. Larger splitting of the spectrum of the OH radical (45 Oe) compared with the HO_2 radical (12 Oe) indicates a correspondingly higher spin density at the proton. (P.C.H.)

37230 SPIN-LATTICE RELAXATION OF Yb^{3+} IN CdF_2. P. P. Pashinin and A. M. Prokhorov (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 5: 261-2(July 1963).

The results are given of an experimental investigation of the spin-lattice relaxation time of Yb^{3+} in CdF_2 samples containing 0.01, 0.05, and 0.1% of the impurity at temperatures of 2–77°K. At helium temperatures an anomalous dependence of the relaxation time on the frequency ($T_1 \propto \nu$) and a dependence on the concentration of paramagnetic ions were observed. (auth)

37231 MAGNETOOPTICAL PROPERTIES OF RARE-EARTH IONS IN FERROMAGNETIC CRYSTALS. G. S. Krinchik (Moscow State Univ.). Soviet Phys.-Solid State (English Transl.), 5: 273-7(Aug. 1963).

A quantitative calculation was made of the frequency dependence of the Faraday effect in europium ferrite garnet caused by exchange interaction between the rare-earth and iron sublattices of the ferrite garnet. Assuming cubic symmetry of the crystal field, the peculiarities of the

polarized absorption spectra and luminescence of rare-earth ions in the ferromagnetic crystal were analyzed. It is shown with the aid of an external magnetic field that it is possible to modify the spectrum of rare-earth ions in a ferromagnet, which suggests the use of the method for creating a controlled laser in a ferromagnetic crystal. (auth)

37232 PROTON POLARIZATION IN IRRADIATED POLYETHYLENES. A. V. Kessenikh, V. I. Lushchikov, A. A. Manenkov, and Yu. V. Taran (Lebedev Inst. of Physics, Moscow and Karpov Research Inst. for Physics and Chemistry, Moscow). Soviet Phys.-Solid State (English Transl.), 5: 321-9(Aug. 1963).

The dynamic proton polarization (DPN) in high-density polyethylenes (HDPE) irradiated by high velocity neutrons was measured at 77, 4.2, and 1.6°K. The results are discussed from the point of view of a simple phenomenological theory of DPN under the conditions of an inhomogeneous broadening of the EPR line. A qualitative estimate based on the experimental data shows that in this case the coefficient of dynamic polarization η may remain constant in a certain temperature region. A linear dependence of η on the mean molecular weight M of the starting samples of HDPE was established. It is shown that this fact can be explained by assuming the equalization of polarization due to the spin diffusion within the limits of isolated domains. A linear dependence of the nuclear relaxation time on the temperature was obtained experimentally, which can be explained on the grounds that the conventional theory, in which spin diffusion is considered as a continuous process, is inapplicable in the case of long electron relaxation times of paramagnetic centers (PC). (auth)

37233 SECONDARY ELECTRON EMISSION OF THE BARIUM OXIDE–TUNGSTEN SYSTEM AT LOW PRIMARY-ELECTRON ENERGIES. N. P. Bazhanova (Kalinin Polytechnical Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 5: 345-7(Aug. 1963).

A study was made of the secondary electron emission from barium oxide films of various thicknesses on tungsten before and after heating. It was found that, irrespective of the initial thickness of the deposited film, after heating at T = 1100°K the system acquired a new stable state characterized by a smaller value of the secondary-electron emission coefficient σ and a new form of the dependence $\sigma(E_p)$. The experimental results show that, apart from partial evaporation of the barium oxide, other processes occur at this temperature. Heating of the system to T ≈ 1500°K caused intense evaporation of the deposited substance. (auth)

37234 ELECTRON PARAMAGNETIC RESONANCE OF Gd^{3+} IN CaF_2. V. M. Vinokurov, M. M. Zaripov, Yu. E. Pol'skii, V. G. Stepanov, G. K. Chirkin, and L. Ya. Shekun (Kazan State Univ.). Soviet Phys.-Solid State (English Transl.), 5: 436-9(Aug. 1963).

Samples of artificial CaF_2 containing Gd(Gd : Ca ~ 1×10^{-4}), sintered in an oxygen atmosphere, were investigated. Four trigonal magnetic complexes with Gd^{3+} were found. The trigonal axes are directed along the body diagonals of the cube of the CaF_2 unit cell. The form of the spin Hamiltonian describing the spectrum was established, and its constants were found. The electron paramagnetic resonance (EPR) is apparently due to Gd(F_1O) complexes. (auth)

37235 TEMPERATURE DEPENDENCE OF THE ELASTIC CONSTANTS OF CESIUM BROMIDE AND IODINE CRYSTALS. S. P. Nikanorov, V. A. Tatarchenko, and A. V. Stepanov (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (English Transl.), 5: 450-5(Aug. 1963).

A study was made of the elastic properties of cesium bromide single crystals in a wide range of temperatures: from room temperature to the vicinity of the melting point. Preliminary data were obtained on the temperature dependence of Young's modulus and the rigidity modulus of a cesium iodide single crystal above room temperature. It was established that, with increase of temperature, the elastic anisotropy of the crystals increases. A rapid rise of the elastic constant s_{44} was observed, in contradiction to theory. (auth)

37236 ELASTIC AND PIEZOELECTRIC PROPERTIES OF CADMIUM PYRONIOBATE IN STRONG ELECTRIC FIELDS. V. A. Isupov and V. N. Skubitskii (Inst. of Semiconductors, Leningrad). Soviet Phys.-Solid State (English Transl.), 5: 701-3(Sept. 1963).

The elastic and piezoelectric properties of polycrystalline specimens were investigated by the dynamical method with the simultaneous application of a constant biasing electric field E to the specimen over a wide range of temperatures in order to determine the phase transition at which spontaneous polarization disappears. In the specimens investigated at E = 0, the maximum in the curve $\epsilon = f(t)$ was found in the region from −84 to −97°C. To the maximum on the curve $\epsilon = f(T)$ there corresponds a sharp minimum on the curve $s = f(T)$. Piezoelectric oscillations were observed also for $T > \Theta_1$, while for large E, piezoelectric oscillations were observed almost up to 0°C. This indicates the presence in the crystal of spontaneous polarization, or the existence in the specimen of individual portions having a spontaneous polarization (associated with some kind of inhomogeneity of the crystal). It was concluded that the larger the field, the lower the temperature necessary to compensate the difference in energy from a state with smaller spontaneous polarization into a state with larger spontaneous polarization and accomplish the phase transition. (P.C.H.)

37237 EFFECT OF ION BOMBARDMENT ON THE ELECTRIC AND PHOTOELECTRIC PROPERTIES OF LEAD SULFIDE. O. M. Artamonov, R. Ya. Berlaga, and M. G. Vinogradov (Leningrad State Univ.). Soviet Phys.-Solid State (English Transl.), 5: 703-5(Sept. 1963).

The ion bombardment method was used to alter the state of oxide layer surface on lead sulfide in a controlled manner. During the bombardment, the conductivity and photoconductivity of the layers, as well as the sign of their thermal emf, was measured. Bombardment of the layer with ions of different gases (hydrogen, oxygen, argon) did not result in any qualitative changes in the shape of resistance change curve, which indicates that the interaction between ions and the surface is not of a chemical nature. The photoconductivity of lead sulfide layers subjected to an ion beam sharply decreased in magnitude, and after a prolonged exposure to ions, it vanished altogether. (P.C.H.)

37238 ON THE CHROMATES(V) OF THE RARE EARTHS. V. THE CHROMATES(V) OF THE RARE EARTHS, $RECrO_4$, FROM SAMARIUM TO LUTETIUM. H. Schwarz (Technische Hochschule, Karlsruhe, Ger.). Z. Anorg. Allgem. Chem., 323: 275-85(July 1963). (In German)

The preparation of the chromates(V) of the rare earth metals from Sm to Lu is described. From Nd to Lu, the chromates(V) crystallize in the structure of zircon. The alteration of lattice constants and unit cell dimensions of these compounds occurring with increasing atomic number

exhibited no discontinuity at Gd. All attempts to prepare the chromates(V) of Sc, Bi, Tl, and In were without any success. The analytical separation of the rare earths from chromium(VI) was achieved by means of cold concentrated $HClO_4$ which does not dissolve CrO_3. (auth)

37239 PYROLYSIS PRODUCTS OF URANIUM TRIOXIDE MONOHYDRATES. I. REFLECTION SPECTRA OF POWDERED URANIUM COMPOUNDS. Z. Urbanec and D. Imrišová (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Z. Anorg. Allgem. Chem., 323: 300-7(July 1963). (In German)

The alteration of the reflection spectra of the products, resulting from the thermal decomposition of $UO_3 \cdot 0.8\ H_2O$ in the temperature range from 150 to 700°C, and of the hydration products of amorphous UO_3 was investigated. The reflection spectra of $UO_3 \cdot 2\ H_2O$ and $UO_{2.9}$ are communicated. The spectra of $UO_3 \cdot 0.8\ H_2O$ and $UO_3 \cdot 2\ H_2O$ indicated that these hydrates contain the uranyl group as a structure unit. (auth)

37240 SURFACE TENSION IN DEUTEROHYDROGEN. V. N. Grigorev (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 98-100(Aug. 1963). (In Russian)

The surface tension coefficient of liquid HD is measured between 16.7 and 20.5°K. In this interval the coefficient linearly depends on the temperature. (auth)

37241 SPIN-ECHO IN LOCAL FIELDS. V. D. Korepanov, A. I. Chernitsyn, and R. A. Dautov (Kazan State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 385-6 (Aug. 1963). (In Russian)

The spin echo of F^{19} nuclei was found in the heterogeneous field of paramagnetic Cd^{3+} ions contained in a CaF_2 monocrystal as an admixture of about 0.01%. The effect was observed only at 4.2°K temperature and below. At 0.38°K the interval between the pulses was 9 to 70 μsec and T_2 = 136 μsec. (R.V.J.)

37242 THE FINE AND HYPERFINE STRUCTURE OF THE 2P STATE OF Li^6 AND Li^7. Kenneth Clair Brog. Thesis, Cleveland, Case Inst. of Tech., 1963. 43p.

An interference phenomenon, which can occur in the resonance fluorescence of an atom when two of its Zeeman levels are brought into coincidence through the application of a magnetic field ("crossed"), was used to investigate the fine and hyperfine structures of the 2P state of Li^6 and Li^7. Two such "crossings" occurred for each isotope, one for a field of approximately 3200 gauss and one for a field of approximately 4800 gauss. Precise determinations of the crossing fields yielded a value of 10,053.3 ± 1.0 Mc/sec for the fine structure splitting in the 2P state of both Li^6 and Li^7. The lower field crossing in Li^7 exhibited a well-resolved hyperfine structure, from which values for the nuclear magnetic dipole interaction constants in the 2P state were obtained. (Dissertation Abstr.)

37243 ANALYSIS OF VIBRATION-ROTATION SPECTRA OF AXIALLY SYMMETRIC MOLECULES, WITH APPLICATION TO CD_3I. John William Boyd. Thesis, East Lansing, Mich., Michigan State Univ., 1963. 71p.

The general problem of the analysis of vibration-rotation spectra of axially symmetric molecules was studied. In order to be able to express the frequency for all possible transitions (as given by the selection rules) a single analytical expression was written for the frequency of the radiation as a function of the quantum numbers and their changes, in which the changes in the quantum numbers were treated as full variables on equal footing with the quantum numbers. Previous treatments gave sets of apparently irreconcilably different expressions for lines in the various portions of bands; whereas, by this method a single expression was obtained that represents all possible transitions. This, in turn, allows a complete band or even several complete bands to be analyzed simultaneously. The statistical problem of estimating many parameters and their reliability from a large number of data points was examined. The concept of simultaneous confidence intervals was applied to this problem. This results of the study were applied to a near infrared absorption spectrum of CD_3I near 4600 cm^{-1}. This spectrum consisted of both a perpendicular ($\Delta K = \pm 1$) and a parallel ($\Delta K = 0$) band. These two bands were assigned to $2\nu_4$ and were analyzed simultaneously. (Dissertation Abstr.)

37244 A STUDY OF THE EFFECTS OF MODIFIER CATIONS ON THE PHYSICAL AND OPTICAL PROPERTIES OF LANTHANUM BORATE GLASS AND ALSO OF SOME RARE EARTH ELEMENTS ON THE PHYSICAL PROPERTIES OF BORIC OXIDE GLASS. Anil Chandra Ghose. Thesis, Rochester, N. Y., Univ. of Rochester. 1962. 225p.

The glass formation region of different lanthanum borate ternary systems containing barium, cadmium, germanium, tantalum, and tungsten was established. The viscosity of molten ternary lanthanum borate systems containing barium, tantalum, and tungsten was determined by the rotating concentric cylinder method. The electrical resistivity of the same systems in the molten state was obtained by measuring the resistance with high frequency a-c bridge. The density of these systems and also of the ternary containing germanium was measured by the sphere-displacement method within the temperature range 970 to 1270°C. The refractive index for the same four ternary systems was obtained by means of a refractometer. The different physical properties, as observed for these systems, were interpreted on the basis of the proposed lanthanum borate matrix and the dual role played by the modifying oxides in inorganic glasses. The density of binary rare earth borates containing small amounts of lanthanum, neodymium, samarium, and yttrium oxides (up to 0.5 mol. %) was determined by the sphere displacement method. The viscosity of these borate systems was calculated from the sphere-displacement data following the method of Stott, Irvine, and Turner. The surface tension of the binary borates containing lanthanum, samarium, and yttrium was determined by the maximum bubble pressure method. Samarium and neodymium seemed to act purely as network modifiers, whereas yttrium played the double role of network modifier and network former. (Dissertation Abstr.)

37245 A STUDY OF THE DISSOLUTION OF Zr–O ALLOYS IN HYDROFLUORIC ACID. Wayne Gilbert Custead. Thesis, Columbia, Mo., Univ. of Missouri, 1962. 192p.

An investigation was made to ascertain and explain, if possible, the effect of oxygen in the metal on the kinetics and electrochemistry of the reaction of zirconium in hydrofluoric acid solutions. The effect of oxygen on the dissolution rates, activation energies, and dissolution potentials, and the difference effect for zirconium in hydrofluoric acid and hydrofluoric-hydrochloric acid mixtures were determined. The dissolution rates of the alloys were determined in a hydrofluoric acid range of 0.10 to 0.50N and a temperature range of 10 to 50°C. The alloy-HF reaction rate decreased with increasing oxygen content. The reaction was first order with respect to the un-ionized HF concentration over the range studied and the reaction order was independent of oxygen content. The ac-

tivation energy for the reaction increased as the oxygen content increased (i.e., from 4.1 ± 0.1 kcal/mole for 1.52% oxygen to 5.2 ± 0.2 kcal/mole for 6.97% oxygen). Additions of hydrochloric acid caused the rates of dissolution of both zirconium and the alloys in hydrofluoric acid to increase greatly whereas the order of the reaction and the activation energies were not altered. The dissolution potentials of the alloys were determined in hydrofluoric acid solutions at 25°C. Difference effect measurements on the alloys showed that: anodic currents have a very strong influence on the dissolution reaction, the difference effect is directly proportional to the current density and independent of the hydrofluoric acid concentration but the proportionality constant increases slightly with oxygen content, hydrochloric acid additions result in an increase in the proportionality constant which relates the difference effect to the current density, there is no noticeable temperature dependency on the proportionality constant in the range 10 to 50°C, and anodic currents cause a slight increase in the activation energy of the dissolution reaction. The results of this investigation strongly suggested that the slow step in the dissolution process is the diffusion of un-ionized HF through effective diffusion layers to the metal surface. It was shown that the experimental results could be correlated with the diffusion rate theory supplemented with Langmuir's adsorption theory. A reaction mechanism for the dissolution process was proposed. It was postulated that oxygen in the metal does not effect the hypothesized mechanism; the free or unbound zirconium of the alloy matrix reacted as if there were no oxygen present. (Dissertation Abstr.)

37246 THE HIGH-RESOLUTION INFRARED SPECTRUM OF O^{18}-ENRICHED CO_2. Charles Victor Berney. Thesis, Seattle, Univ. of Washington. 1962. 92p.

The infrared spectrum of a sample of CO_2 enriched to about 10 at. % with O^{18} was examined in the region of 5400 to 1620 cm^{-1}, using an Ebert grating spectrometer with spectral slit widths ranging from 0.4 to 0.2 cm^{-1}. Various bands of O^{18}-substituted species of CO_2 were observed, including several which were not previously reported under comparable resolution. These are given, together with the observed band centers in cm^{-1}. The data are compared with values calculated from vibrational constants given by Courtoy (Ann. Soc. Sci. Bruxelles 73: No. I, 1959). Band centers for the unsymmetrical species were found to be consistently higher than calculated, by 0.2 to 1.3 cm^{-1}. The anomalously large Fermi resonance constant (52.5 cm^{-1}) found by Courtoy for $C^{12}O^{16}O^{18}$ was confirmed, and the $C^{12}O^{18}$ bands observed indicated that it is even higher (around 53.7 cm^{-1}) for the doubly-substituted species. Rotational data for $C^{12}O^{16}O^{18}$ indicated that α_3 is about 287 × 10^{-3} cm^{-1}, slightly smaller than the value suggested by Courtoy. (Dissertation Abstr.)

37247 COVALENCY EFFECTS AND LATTICE VIBRATION SPECTRA OF Pr^{3+} AND Nd^{3+} IN $LaCl_3$ AND $LaBr_3$. Isaac Richman. Thesis, Los Angeles, Univ. of California, 1963. 149p.

The absorption and fluorescence spectra of LaBr single crystals doped with 1% Pr^{3+} and 0.5% Nd^{3+} were obtained, and from them energy levels determined. It was found that the Stark splitting of these two ions in $LaBr_3$ was almost identical to that in $LaCl_3$ indicating that the crystalline fields in the two crystals are also almost identical. However there was a shift of centers of gravity of the J levels in $LaBr_3$ to the red relative to those in $LaCl_3$. A model which takes into account the covalent bonding between the lanthanide and its neighbors was proposed, and from it a method for determining the change in covalent bonding in going from one crystal to another. This method depends on the change in Slater integrals and spin-orbit parameter. It was applied to both Pr^{3+} and Nd^{3+} in $LaCl_3$ and $LaBr_3$ and it was found that the model could account for approximately 75% of the difference in J levels in these two crystals. The calculations fit the shifts with an average deviation of 12.7 cm^{-1} for Pr^{3+} and 17 cm^{-1} for Nd^{3+}. The absorption spectra of Pr^{3+} in $LaCl_3$ and $LaBr_3$ were studied. These spectra exhibited satellite lines lying close to lines which are known to result from electronic transitions. It is known that these satellite lines cannot arise from pure electronic transitions since there are far more such lines than possible electronic transitions could yield. It was assumed that the satellite lines in spectra of lanthanides in $LaCl_3$ result from a simultaneous change in lanthanide electronic state and some crystalline vibrational state. To test this hypothesis spectra of single crystals of $LaCl_3$ and $LaBr_3$ doped with Pr^{3+} were obtained in the photographable region. $LaBr_3$ is isomorphous to $LaCl_3$ and has very similar chemical properties. Therefore if the hypothesis is correct the major effect of the change of anion from Cl^- to Br^- would be a shift of vibrational levels to the red because of the increased mass. The satellite spectra of the two crystals were quite similar and the shift to the red was observed. The amount of the shift was that expected from the hypothesis. The number and symmetry types of unit cell normal modes was calculated, as well as a set of unit cell symmetry coordinates. From the symmetry types selection rules in the so-called k = 0 approximation were obtained for electronic-vibrational transitions. It was found that the calculated selection rules could account for most of the observed transitions, and that in those cases where violations of the selection rules occur the observed transitions were weak relative to those allowed. It was shown from theoretical considerations that the k = 0 selection rules would not be expected to hold. The experimentally observed fact that they are not drastically violated indicated that the optical phonon branch energies are relatively independent of k. This conclusion was also attested to by the narrow (<10 cm^{-1}) widths of most of the satellite lines. Spectra of pure $PrCl_3$ and $PrBr_3$ were also obtained. Their satellite spectra were similar to those of their dilute counterparts except for the appearance of several new lines. Some possible explanations for these lines are given but their origin remains in doubt. A tentative assignment of symmetry type to the observed vibrational levels is given. (Dissertation Abstr.)

Organic Chemistry

Refer also to abstract 38032.

37248 (EUR-295.f) SYNTHÈSE DE PRODUITS DE RÉFÉRENCE APPARENTÉS AUX POLYPHÉNYLES (2e PARTIE). (Synthesis of Reference Products Allied to Polyphenyls (2nd Part)). Final Report. C. Beaudet, J. Horlait, and A. Marcq (Brussels. Société d'Études, de Recherches et d'Applications pour l'Industrie). 1963. 67p.

A description is given of the preparation and the characteristics of a new series of quinquephenyls and hexaphenyls. (auth)

37249 (TID-17647) PREPARATION OF TERTIARY-ALKYLPHOSPHONYL DICHLORIDES. T. H. Siddall, III and C. A. Prohaska (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1963. Contract AT(07-2)-1. 5p.

The use of 1-halo-2-alkylalkanes in the reaction of

Kinnear and Perren was found to result in the formation of tert-alkylphosphonyl dichlorides in yields of 20 to 40%. The reaction involves adding 1 mole alkyl bromide to 1 mole PCl_3 + 1 mole anhydrous $AlCl_3$ in 400 ml CH_2Cl_2 at ~0°C; stirring the reaction mixture overnight at room temperature; separating the phases; pumping off the CH_2Cl_2; and finally carrying out distillation. The following phosphonyl dichlorides were prepared in this manner: 2-methylbutyl-2-, 3-methylamyl-3-, and 3-methylheptyl-phosphonyl dichloride. Proton magnetic resonance spectra are given for these compounds and for tert-butylphosphonyl dichloride. (D.L.C.)

37250 A STUDY OF THE METALATION REACTION USING HYDROGEN ISOTOPES. Kenneth Ray Barton. Thesis, Knoxville, Tenn., Univ. of Tennessee, 1963. 143p.

The primary kinetic hydrogen isotope effects in the metalation of thiophene with n-butyllithium were studied. The protium-deuterium isotope effect (k_H/k_D) was established to be 6.6 ± 0.3 at 35°. This value is in close agreement with the theoretical value calculated on the basis of the zero-point-energy approximation. A strong protium-tritium isotope effect was also found in this reaction. A definitive value for k_H/k_T was not established, but the data obtained indicate that the rate-constant ratio approaches the theoretical maximum value predicted by the zero-point-energy approximation, $k_H/k_T = 17$. Since the isotope effects were found to be relatively strong, the cleavage of the carbon-hydrogen bond at the position to be metalated appeared to be considerably advanced in the transition state leading to proton removal. The agreement between theoretical and experimental values was an indication of the validity of the zero-point-energy approximation for this system. These observations are in accord with the "protophilic" view of the metalation mechanism. The metalation of thiophene in the 2-position was found to be an essentially quantitative process. No evidence of 3-metalation could be detected in a vapor phase chromatographic analysis of the metalation product. Excess quantities of n-butyllithium produced 2,5-dimetalation in the thiophene molecule. The proton transfer in the metalation reaction of thiophene and t-butylbenzene with n-butyllithium and n-butylpotassium, respectively, was followed by deuterium substitution. Deuterium displaced by the metal atom was found to be transferred to the carbon atom of the metalating agent which originally carried the carbon-to-metal bond. There was no evidence to indicate that the beta-carbon atom of the metalating agent becomes involved in the metalation sequence. This is an indication of proton abstraction by a primary carbanion and is in agreement with the 4-member transition state proposal of Bryce-Smith. (Dissertation Abstr.)

Radiation Chemistry and Radiochemistry

Refer also to abstracts 38036, 38076, and 38444.

37251 (NAA-SR-5200) THERMOPHYSICAL PROPERTIES OF IRRADIATED POLYPHENYL COOLANTS. PART II. ENTHALPY AND SPECIFIC HEAT. G. Asanovich, R. H. J. Gercke, and R. S. Moore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 30, 1963. Contract AT-11-1-GEN-8. 28p.

Enthalpy and specific heat values were determined over the temperature range of 300 to 850°F with a Southard drop type calorimeter for polyphenyl organic materials of interest as organic reactor coolants. The enthalpy determinations, which form the basis for the specific heat values, were performed in duplicate at 50 to 100°F intervals. The specific heat of unirradiated Core I OMRE coolant was found to be 0.492 Btu/lb-°F at 400°F and increased linearly by about 0.037 Btu/lb-°F for each 100 degree increase in temperature. The specific heat of irradiated OMRE coolants decreased linearly with increasing HB content at 600°F. Experimental enthalpy measurements were also made on biphenyl, Santowax OMP, and Santowax R; however, the enthalpy and specific heat values are considered to be biased due to the effects of solidification of these higher melting materials on the thermal transient in the calorimeter. (auth)

37252 (RRL-118) OBSERVATIONS ON SPUR REACTIONS IN THE LIQUID PHASE γ-RADIOLYSIS. Ralph N. Schindler (Mellon Inst. Radiation Research Labs., Pittsburgh and Kernforschungsanlage, Julich, Germany). Sept. 10, 1963. Contract AT(30-1)-2310. 13p.

Propane and butane formation is observed in the liquid-phase γ radiolysis of mixtures of methyl with ethyl iodide; butane and ethane formation occurs when mixtures of methyl with n-propyl iodide are irradiated. The G-values for these products are not affected by $\leq 10^{-2}$ moles/l DPPH. These observations and the dependence of G (recombination products) on the composition of the mixtures strongly suggest that these hydrocarbons are formed by diffusion-controlled recombination in spurs. (auth)

37253 (TID-19351) RADIATION CHEMISTRY OF ORGANIC SYSTEMS. Progress Report No. 4, January 1, 1962–September 15, 1962. James A. Knight, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Sept. 30, 1962. Contract AT(40-1)-2490. 34p.

Studies were made on the radiolysis products of 2,2,4-trimethyl-pentane and 2,2,4,6,6-pentamethylheptane. At least 40 radiolysis products in the C_8-C_{16} range were obtained from irradiated TMP. Comparison of the total G values for C_8-C_{16} products, G ~ 2.4, with the total G value for C_1-C_7 products, G ~ 5.6, showed that the processes leading to the lower molecular weight products predominate. Molecular weight measurements along with gas chromatographic analysis indicated that the highest molecular products are those due to dimerization of two C_8 components, at least in the earlier stages of irradiation. In addition to hydrogen, there were at least 73 radiolysis products from the x irradiation of PMH. 34 of the products were in the C_1-C_{11} range with a total G ~ 4.9 and 39 were in the $C_{12}-C_{24}$ range with a total G ~ 2.1. In the C_1-C_{11} range, the processes that lead to a product that can be related to some portion of the carbon skeleton of the parent hydrocarbon predominate. The results indicated very strongly that the highest molecular weight products, at least in the earlier stages of radiolysis, are those of C_{24} carbon content. (P.C.H.)

37254 (TID-19381) G-VALUES FOR SOME INHIBITORS OF POLYMERIZATION IN A MONOMER (thesis). LaMar J. Johnson (Kansas. Univ., Lawrence). Aug. 1963. 70p.

Experiments were conducted to measure the degree of protection afforded the monomer triethylene glycol dimethacrylate (TEDMA) by some additives against polymerization by the absorption of thermal and ionizing radiation energy. G-values were calculated for the various additives studied both with and without the presence of oxygen. The values were based on the measured induction period prior to radioinduced gelation. The stable free

radical diphenylpicrylhydrazyl (DPPH), which was used as a standard reference, showed a G-value of 7.1 in the absence of oxygen and 6.03 in the presence of an oxygen pressure of 2 mm Hg. The depression of the G-value with the addition of oxygen was attributed to competition of DPPH and oxygen for the primary radicals produced. The radioinduced radical yield as calculated by the DPPH method was 4.44×10^{12} radicals/g TEDMA/rad in the absence of oxygen and 3.77×10^{12} radicals/g TEDMA/rad in the presence of oxygen. The extreme sensitivity of the monomer solutions to the presence of traces of oxygen prompted a study of the degassing characteristics of monomer solutions. It was shown that solution deaeration could be accomplished by a short outgassing period under vacuum followed by a longer diffusion period. A unique method of determining small oxygen concentrations in monomer solutions was made possible by use of triphenylstibine. (P.C.H.)

37255 THE GRADUAL NATURE OF THE RADIATION-CHEMICAL PROCESSES OF AROMATIC COMPOUNDS IN AQUEOUS MEDIA. S. A. Safarov (Inst. of Chemistry, Azerbaijan Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 151: 890-3(Aug. 1, 1963). (In Russian)

The mechanism of the radiolysis of dilute (10^{-2}M) aqueous solutions of aromatic compounds (RH_2) such as thiophene, pyridine, furan, benzene, and pyrrole was investigated, irradiating the RH_2–water system with radiation from Co^{60} at pH = 7. The products were analyzed by nephelometric, ultraviolet, and ordinary spectroscopic methods. As a general rule, oxyproducts and "dimer-1" type materials (precipitates in the residue) were obtained. The second product was formed slowly, after an incubation period, the length of which was found to depend on the dose. Irradiation of the thiophene resulted first in the relatively rapid increase of the oxyproduct, followed by an increase of the formation of the "dimer-1". The latter is probably formed by the subsequent radiation-chemical condensation of the oxyproducts. Two successive first-order reactions are involved in these processes. Results point to the presence of a gradual process in the radiolysis. In inert media in addition to the oxyproducts, molecular H is formed, while in O atmosphere H_2O_2 and the oxyproducts are obtained. This gradual mechanism is due to the fact that a complete oxydation or reduction reaction requires an even number of the equivalents but the radiolysis of water yields only a single equivalent (H, OH, HO_2); also transformation with uneven number of electrons take place, as shown by the formation of free radicals. (T.T.T.)

37256 IONIZATION OF Si RECOIL NUCLEI IN Si DETECTOR DIODES BY IRRADIATION WITH NEUTRONS FROM 3.0 TO 3.9 Mev. H. Bilger, E. Baldinger, and W. Czaja (Universität, Basel). Helv. Phys. Acta, 36: 405-12(1963). (In German)

Measurements of Si-recoil spectra were performed in Si-detector diodes, which were irradiated with monoenergetic fast neutrons. In the same experiment the mean energy ϵ to create an electron-hole pair of α particles was compared with the ϵ of the recoil ions. In the case of Si-ions the results indicated a much higher value of ϵ. A model is suggested to account for the measured defects. This model gives also a rough estimate for the ionization defects of other ions in semiconductors. (auth)

37257 RUPTURE OF FOAM BY NUCLEAR IONIZED PARTICLES. Ryuhei Kato and Toshihiko Kōno (Ritumeikan Univ., Kyoto). J. Appl. Phys., 34: 708(Mar. 1963).

A neutral aqueous soap solution with a good foam-holding capacity was irradiated with alpha particles from a Po^{210} source. The rupture of the bubbles was found more frequent at the end of the particle tracks. (R.E.U.)

37258 PHOTOCONTROL OF GROWTH RATE OF THIN POLYMER FILMS FORMED BY ELECTRON BOMBARDMENT. Ludwig Mayer (General Mills Electronics Group, Minneapolis). J. Appl. Phys., 34: 2088-93(July 1963).

The formation of thin polymer films on metal film substrates bombarded by slow electrons is investigated. The essential results of the investigation are: Cracking, polymerization, and crosslinking of organic molecules adsorbed on surfaces by electron bombardment can be achieved with electron energies as low as 6 ev. The formation rate of thin polymer films in the low electron region is voltage-dependent. Polymer films formed from organic molecules inherently present in a high vacuum system show electrical photoresponse in the visible and near-infrared region of the spectrum. By utilizing this photoresponse and the voltage of dependence of the film growth rate, polymer film configurations can be grown that correspond to light patterns projected onto them. All experiments were conducted in an electron mirror microscope that proved to be ideally suited for this type of study. Such a microscope is a very sensitive tool for the detection and observation of extremely thin insulating films. It permits formation of thin polymer films in an easy fashion and it serves equally well as a convenient instrument for immediate detection and study of such films during growth. The transition from growing polymer films to observing them can be accompanied simply by switching the bias potential on the polymer film's conductive substrate. In one example, illustrated by an electron mirror micrograph, the experimental procedures are described in detail. (auth)

37259 YIELD OF "FREE IONS" IN GAMMA-IRRADIATED LIQUID SATURATED HYDROCARBONS. G. R. Freeman (Univ. of Alberta, Edmonton). J. Chem. Phys., 39: 988-96(Aug. 15, 1963).

When a hydrocarbon is subjected to ionizing radiation, some of the electrons that are ejected from the molecules escape the electric field of their parent ions. An escaped electron and its parent ion can diffuse independently of each other, so they may be considered as free ions. The number of electrons that escape their parents per hundred electron volts of energy absorbed by the system, $G(esc\ e^-)$, is approximately 0.2. This value was determined by conductance measurements and is probably accurate to within a factor of 50%. From numerical analysis of delta-ray energy spectra, it appears that secondary electrons with energy greater than 30 or 40 ev can escape from their parent ions. (auth)

37260 MASS-SPECTROMETRIC STUDY OF IONS FROM THE α-PARTICLE IRRADIATION OF GASES AT NEAR ATMOSPHERIC PRESSURES. P. Kebarle and E. W. Godbole (Univ. of Alberta, Edmonton). J. Chem. Phys., 39: 1131-2(Aug. 15, 1963).

Description is given of an instrument constructed to allow the mass-spectrometric study of ions produced at near-atmospheric pressures. The mass spectrum of ethylene obtained at 200 Torr consisted of a very large number of peaks. No fragment ions of ethylene were observed. The main ions contained an odd number of hydrogen atoms. Saturated hydrocarbons and other systems were also examined. The paraffin spectra were complex and showed very great sensitivity to trace amounts of impurities (olefins). Thus with air containing less than 1% H_2O the major ions observed were $H^+(H_2O)_n$. (P.C.H.)

37261 RADIATION CHEMISTRY OF LIQUID ETHANE. Hugh A. Gillis (Mellon Inst., Pittsburgh). J. Phys. Chem., 67: 1399-1401(July 1963). (RRL-86; NYO-10307)

Product yields of the radiolysis of liquid ethane at −78° with x rays have been determined to be: $G(H_2) = 3.60$, $G(n\text{-}C_4H_{10}) = 2.54$, $G(C_2H_4) = 0.73$, $G(C_3H_8) = 0.65$, $G(CH_4) = 0.56$, and $G(C_2H_2) = 0.11$. From the results it was calculated that $G(CH_3\cdot)/G(C_2H_5\cdot) \leq 0.10$. This is approximately as expected from previous esr experiments on liquid ethane in which the ratio of steady-state concentrations of methyl and ethyl radicals was estimated to be 0.04. (auth)

37262 THE "DIRECT EFFECT" IN THE RADIOLYSIS OF AQUEOUS SODIUM NITRATE SOLUTIONS. H. A. Mahlman (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 1466-9(July 1963).

Oxygen-18 enriched water was used to determine the source of molecular oxygen formed during the Co^{60} γ radiolysis of aqueous sodium nitrate solutions. Mass spectrographic analyses of the O_2 indicated that the oxygen came from two sources: the joint participation of H_2O and NO_3^- and from the nitrate ions. The oxygen formed by decomposition of the nitrate ion is directly proportional to the dissolved solute. Since nitrite ion is the only major nitrogen-containing radiolysis product, the overall decomposition is consistent with $NO_3^- \rightarrow NO_2^- + 0.5\ O_2$. The $G(O_2)$ was measured in the Ce^{4+} – 0.4M H_2SO_4–$NaNO_3$ system and, like the $G(Ce^{3+})$ in this system, increased rapidly as a function of the $NaNO_3$ concentration at low $NaNO_3$ concentrations and at a slower rate, directly proportional to $NaNO_3$ concentration, at high $NaNO_3$ concentrations. The $G(O_2)$ from radiolysis of the NO_3^- in H_2O^{18}–$NaNO_3$ solutions was correlated with the directly proportional regions of the $G(Ce^{3+})$ and the $G(O_2)$ measured in the Ce^{4+} – 0.4M H_2SO_4–$NaNO_3$ system. (auth)

37263 THE INFLUENCE OF INCORPORATED RADIOACTIVITY AND EXTERNAL RADIATION ON THE DEHYDRATION OF CYCLOHEXANOL OVER SULFATE CATALYSTS. N. A. Krohn and Hilton A. Smith (Univ. of Tennessee, Knoxville and Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 1497-1501(July 1963).

The vapor phase dehydration of cyclohexanol on magnesium sulfate and magnesium sulfate–sodium sulfate catalysts was studied. The effects of the incorporation of radioactive sulfur into the sulfate radical, of x irradiation of the catalyst while in use, and of preirradiation with Co^{60} γ rays were investigated. When compared on a unit surface area basis, the radioactive catalysts were found to be less active than non-radioactive catalysts of similar composition. This effect persisted even after the radioactivity had substantially decayed. Neither preirradiation with Co^{60} γ rays nor x irradiation of the catalyst while in use had any effect. It was concluded that the reported enhancements of catalytic activity upon the incorporation of S^{35} are erroneous and that the emission of β-particles from the catalyst during its use is of no consequence. The reports of enhanced catalytic activity may be attributed to the fact that for a given set of preparative conditions the radioactive catalysts had larger surface areas than their non-radioactive counterparts and that apparently this had not been considered. (auth)

37264 RADIOCARBON-LABELED COMPOUNDS PRODUCED BY THE NEUTRON IRRADIATION OF GUANIDINE HYDROCHLORIDE. Thomas W. Lapp and Robert W. Kiser (Kansas State Univ., Manhattan). J. Phys. Chem., 67: 1559-61(July 1963).

Crystalline guanidine hydrochloride was irradiated by neutrons and studies were made on the C^{14}-labeled compounds present when the target material was dissolved in water. The results indicate that the cyanamide radical plays an important role in the production of the final chemical species incorporating the recoil C^{14} atom. The production of the cyanamide radical may occur by a replacement reaction of the C^{14} atom with a guanidine molecule within the solid matrix, after the recoil atom has been slowed down to the point where it is stable toward recombinations. This results in the rupture of a $C-NH_2$ bond and leads to the formation of the radiocarbon labeled cyanamide radical, which may then undergo reactions with other molecules of the matrix to produce the final chemical compounds observed. Significant amounts of activity were found in cyanoguanidine (12%), acetamidine (11%), guanylguanidine (16%), and melamine (22%). There appeared to be no significant interaction of the solvent with the irradiated target material. (P.C.H.)

37265 THE REACTION OF H ATOMS WITH OH^- IN THE RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. Shlomo Nehari and Joseph Rabani (Hebrew Univ., Jerusalem). J. Phys. Chem., 67: 1609-13(Aug. 1963).

Using 200-kvp unfiltered x rays, the effect of pH on reduction and dehydrogenation reactions of H atoms was studied. It was concluded that the reducing radicals in water radiolysis include H atoms with a yield of about 0.48 ± 0.05. The yield is independent of pH between 2 and 13. In the alkaline solutions, H atoms are converted into a species that reacts with scavengers in the same manner as radiation produced e^-_{aq}. The reactivity of H atoms with nitrate, acetate, acetone, OH^-, and bicarbonate was studied. (auth)

37266 ENERGY PARTITION IN THE RADIOLYSIS OF AROMATIC MIXTURES. C. E. Klots and R. H. Johnsen (Florida State Univ., Tallahassee). J. Phys. Chem., 67: 1615-17(Aug. 1963).

Yields of products from the x irradiation of liquid benzene, pyridine, and their mixtures were investigated. The yields may be largely understood on the basis of the generation of precursors to all products in accordance with the electron fraction parameter. This is interpreted as placing limitations on a disproportionate role for direct excitation to low level states leading to selective energy absorption and as indicating a negligible role of intermolecular transfer of chemically consequential excitations in liquid aromatic systems. (auth)

37267 RADIOLYSIS OF n-BUTENES. Priscilla Chang Kaufman (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 67: 1671-4(Aug. 1963). (BNL-6702)

The radiolyses of 1-butene, cis-2-butene, and trans-2-butene with γ rays were studied in gas and liquid phases, at −78°C and room temperature. In all cases, the major products were the C_8 hydrocarbons, the saturated monomer, the geometric isomer (trans- from cis-2-butene), the double-bond isomer (1-butene from 2-butene), hydrogen, and unidentified high polymers. Small amounts of C_2, C_3, C_5, C_6, and C_7 hydrocarbons were also formed. The C_8 hydrocarbons produced were examined for carbon skeleton and extent of unsaturation. Comparison of the results with 1-hexene radiolysis led to the conclusion that the ion-molecule mechanism previously proposed is applicable. (auth)

37268 CHEMICAL EFFECTS OF (n,γ)-ACTIVATION OF HALOGEN ATOMS IN ALKYL HALIDE–PENTANE SOLUTIONS; AUGER ELECTRON REACTION HYPOTHESIS. Paul R. Geissler and John E. Willard (Univ. of Wisconsin, Madison). J. Phys. Chem., 67: 1675-80(Aug. 1963).

Solutions of methyl iodide, ethyl iodide, amyl iodide, and propyl chloride in pentane were irradiated with neutrons and the organic products formed by halogen atoms that underwent radiative neutron capture ($I^{127}(n,\gamma)I^{128}$ or $Cl^{37}(n,\gamma)Cl^{38}$) were determined by gas chromatography. In each of the iodide solutions the largest fraction of the I^{128} activity was found in the form of the parent alkyl iodide even in the presence of I_2 scavenger. Evidence from other studies indicates that failure of bond rupture, recombination of parent partners, or exchange of I^{128} with an alkyl iodide molecule following the (n,γ) process is improbable in these systems. The hypothesis is suggested that the recoil I^{128} atoms react with parent-type R radicals that are formed at high localized concentration in their immediate vicinity by reactions such as $RI + e^- \rightarrow R + I^-$ and $RI + H \rightarrow R + HI$ made possible by the localized radiation chemistry induced by the internal conversion and Auger electrons emitted by the recoil atoms. The relative yields of I^{128} products are similar to those of I^{131} products observed in the Co^{60} radiolysis of solutions of alkyl iodides in pentane containing I_2^{131} scavenger. If the hypothesis is correct that the chemical fate of an I^{128} atom is influenced by the decomposition of the immediately surrounding envelope of solvent by conversion electrons and Auger electrons, similar autoradiation processes may be significant in many other systems where chemical activation by nuclear processes has been studied. The organic yield of I^{128} from neutron irradiation of unscavenged alkyl iodide–pentane solutions was observed to increase from 50 to 90% with time of irradiation from 1 sec to 1 min at a neutron flux of about 10^{13} neutrons cm^{-2} sec^{-1} and a γ-dosage rate of about 3×10^{18} ev g^{-1} min^{-1}. Equivalent γ radiation administered prior to the neutron irradiation does not cause such an increase. (auth)

37269 SINGLY- AND DOUBLY-CHARGED IONS FROM METHYL AND ETHYL ISOTHIOCYANATES BY ELECTRON IMPACT. Brice G. Hobrock, Roger C. Shenkel, and Robert W. Kiser (Kansas State Univ., Manhattan). J. Phys. Chem., 67: 1684-6(Aug. 1963).

Electron impact data are presented for methyl and ethyl isothiocyanates. Partial mass spectra and appearance potentials for some singly- and doubly-charged ions are also given. The heats of formation of NCS and HNCS were found to be 97 and 18 kcal/mole, respectively, leading to D(H–NCS) = 131 kcal/mole. The proton affinity of isothiocyanic acid is –150 kcal/mole and the ionization potential of the NCS radical is $\leq 10.4 \pm 0.3$ ev. (auth)

37270 THE REACTIONS OF ENERGETIC CARBON ATOMS IN METHANE; OXYGEN AND PHASE DEPENDENCE; RADIATION DAMAGE EFFECTS. G. Stoecklin, H. Stangl, D. R. Christman, J. B. Cumming, and A. P. Wolf (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 67: 1735-7(Aug. 1963). (BNL-6687)

Studies were made on the reactions of C^{11} in methane containing oxygen. The nuclear reactions $C^{12}(n,2n)$ and $C^{12}(p,pn)$ were used to produce C^{11}. Concomitant radiolysis of the methane during C^{11} production clearly affected product distribution. C^{11}-labeled ethane and propane decreased while methane, ethylene, and acetylene decreased. It was assumed that reduction by hydrogen atoms was probably occurring in the unscavenged system. The effects of oxygen and of phase are discussed. In all cases, in duplicate systems, the product distributions resulting from inducing the $C^{12}(p,pn)$ reaction were the same within experimental error as those resulting from the $C^{12}(n,2n)$ reaction. (P.C.H.)

37271 EVIDENCE FOR A TRACK EFFECT IN THE RADIOLYSIS OF LIQUID CYCLOHEXANE. J. W. Falconer and Milton Burton (Univ. of Notre Dame, Ind.). J. Phys. Chem., 67: 1743-6(Sept. 1963).

A detailed examination of the yields of liquid products in the Hg-photosensitized reactions and in the radiolytic reactions in liquid cyclohexane, induced, respectively, by 1.8-Mev electrons, by Co^{60} γ rays, and by Po^{210} α-particles, shows that the ratio $G(C_6H_{10})/G(C_{12}H_{22})$ increases with LET. (auth)

37272 POLYMERIZATION OF BUTADIENE GAS ON SURFACES UNDER LOW ENERGY ELECTRON BOMBARDMENT. I. Haller and P. White (International Business Machines Corp., Yorktown Heights, N. Y.). J. Phys. Chem., 67: 1784-8(Sept. 1963).

The kinetics of the formation of butadiene polymer film was investigated on a surface exposed to 250 ev electrons. In the presence of butadiene vapors at pressures between 3×10^{-4} and 10^{-6} torr, the rate of growth of the transparent film, insoluble in benzene, acetone, CCl_4, or CS_2, was found proportional to the square root of the current density. The rate increased with increasing pressure, becoming independent at higher values of pressure. The kinetics was interpreted to indicate that after the first layer of polymer has formed, subsequent layers grow by interaction of adsorbed monomer gas with active species, probably positive ions in the polymer. The measured lifetime of the active species is about 3 min. The apparent activation energy is -6 ± 2 kcal/mole. (auth)

37273 MECHANISM OF RADIOLYSIS OF OLEFIN IN PARAFFIN SOLUTION. 1-PENTENE IN n-BUTANE. C. D. Wagner (Shell Development Co., Emeryville, Calif.). J. Phys. Chem., 67: 1793-5(Sept. 1963).

A detailed examination of the products of radiolysis of a 0.5M solution of 1-pentene in butane confirmed that most of the olefin reacts by addition of a hydrogen atom. The remainder reacts by hydrogen abstraction from allylic positions by hydrogen atoms and by a variety of unknown energy transfer or charge transfer mechanisms. (auth)

37274 THE RADIOLYSIS OF ARALKYL KETONES. D. J. Coyle (Univ. of Chicago). J. Phys. Chem., 67: 1800-2(Sept. 1963).

Gamma radiolysis of the neat, degassed ketones n-butyrophenone, isobutyrophenone, and benzoylcyclopropane was studied with regard to volatile products. The total G-values of products volatile at –78° are given. The major volatile product from n-butyrophenone was ethylene (88% at lowest dosage); acetophenone was found in the liquid phase in roughly comparable amounts. Neither of the other ketones displayed such specificity of product formation. Hydrogen, carbon monoxide, propane, and propylene were significant products from each of the ketones, but in varying proportions. Hydrogen and the olefinic products exhibited decreasing G-values with increasing total radiation dosage. The products were observed in each instance to be similar to those generated by photolysis with 2537-Å radiation, except for hydrogen, which was an insignificant product from photolysis. From comparison with the mass spectra and photolysis data, the tentative conclusion was that the mechanisms for product formation during radiolysis are similar to those of photolysis. The data are not sufficient, however, to establish a particular mechanism. (P.C.H.)

37275 THE RADIATION CHEMISTRY OF ALKALINE HYPOBROMITE SOLUTIONS. C. H. Cheek and V. J. Linnenbom (Naval Research Lab., Washington, D. C.). J. Phys. Chem., 67: 1856-60(Sept. 1963).

The yields of bromate, bromide, oxygen, and hydrogen in γ irradiated alkaline hypobromite solutions were measured. $G(-BrO^-)$ is independent of temperature, dose rate,

and base strength in the range 0.01 to 1.0M NaOH. It increases rapidly with initial hypobromite concentration up to 10^{-3}M and much more slowly at higher concentrations. In 4 mM BrO^- solution at pH 13, $G(-BrO^-) = 5.6$ and is independent of the concentration of oxygen and hydrogen, but is decreased by added bromide and bromate. The common inorganic impurities have no effect on the results. The results are interpreted in terms of a mechanism including the following reactions: $e^-_{aq} + BrO^- \xrightarrow{H_2O} Br^- + OH^- + OH$ (1), $OH + BrO^- \rightarrow OH^- + BrO$ (2), $[4BrO + 4OH^- \rightarrow 3BrO^- + BrO_3^- + 2H_2O]$ (3), and $HO_2^- + BrO^- \rightarrow Br^- + OH^- + O_2$ (4). Extrapolation of product yields to zero BrO^- concentration gives the following primary yields at pH 13: $G_{e^-_{aq}} = 2.8$, $G_{OH} = 2.1$, $G_{H_2} = 0.45$, $G_{HO_2^-} = 0.84$, and $G_{-H_2O} = 3.7$. Comparison of the results to those for neutral and very weakly acidic solutions indicates that the yields of the radiolysis products of water are essentially constant in the pH range 4 to 14. The alkaline hypobromite system has excellent qualifications for use as a chemical dosimeter. (auth)

37276 Co^{60} γ-RAY INDUCED COPOLYMERIZATION OF ETHYLENE IN THE PRESENCE OF OTHER MONOMERS. P. Colombo, M. Steinberg, and D. Macchia (Brookhaven National Lab., Upton, N. Y.). J. Polymer Sci., Pt. B, 1: 483-8(Sept. 1963). (BNL-7134)

The experimental approach was used to determine if copolymerization of ethylene with various monomers occurs in a radiation field, and to investigate some of the properties of the resulting polymers. In the copolymer systems, the reaction products were free of homopolymer except for the systems with vinyl acetate, vinyl chloride, and acrylonitrile. Ethylene gas can react with a variety of monomeric materials to form copolymers at low temperatures and moderate pressures. Unsaturated monomers, such as propylene and the butenes, which do not readily homopolymerize in a radiation field, or by a free radical mechanism can be copolymerized with ethylene by gamma radiation. Data on solubilities, density, crystalline melting point, molecular weight, total polymer formed, and total conversion for the ethylene copolymers are tabulated. (P.C.H.)

37277 THE TRANSFORMATION OF 5-BROMOURACIL-2-C^{14} BY X RADIATION IN VITRO AND IN VIVO. E.-R. Lochmann (Freien Universität, Berlin). Naturwissenschaften, 50: 520-1(1963). (In German)

5-bromouracil-2-C^{14} in distilled water, sodium acetate solution, and yeast extract bouillon was exposed to 900 kr x radiation, and the transformation products were determined. The 5-bromouracil was also introduced into Enterococcus stei before exposure to x radiation. Paper chromatography was used to separate the bromouracil, uracil, urea, and three unidentified compounds. Only slight amounts of uracil were found in the distilled water. In sodium acetate, bouillon, and the bacteria cells, the pyrimidine ring of the bromouracil is only slightly attacked, but extensive dehalogenation and uracil formation are evident. (J.S.R.)

37278 THE RADIATION INDUCED OXIDATION AND REDUCTION REACTIONS OF IRON IN AQUEOUS SOLUTIONS. III. THE REDUCTION OF Fe(III) IONS IN PERCHLORIC AND SULPHURIC ACIDS. THE EFFECTS OF ISOBUTYL ALCOHOL. Roman Broszkiewicz and Stefan Minc (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 157-63(1963). (In English)

The reduction of ferric ions in solutions of perchloric and sulfuric acids in concentrations of 10^{-3} or 10^{-1} N in the presence of isobutyl alcohol used as an acceptor of OH radicals was investigated. The effects of the structure of ferric complexes are discussed. A mechanism of reduction reactions of ferric ions by the formed organic radicals is proposed. (auth)

37279 THE RADIATION INDUCED OXIDATION AND REDUCTION REACTIONS OF IRON IN AQUEOUS SOLUTIONS. IV. THE REDUCTION OF Fe(III) IONS IN PERCHLORIC AND SULPHURIC ACIDS SOLUTIONS. THE EFFECTS OF MOLECULAR HYDROGEN. Roman Broszkiewicz and Stefan Minc (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 165-75(1963). (In English)

The reduction of ferric ions in solutions of perchloric and sulfuric acids in concentrations 10^{-3} or 10^{-1} N under the pressure of hydrogen 100 atm was investigated. It was confirmed that in solutions of the 10^{-3}M acids $G_{Fe^{3+}}$ amounted to 3.0 for both solutions. In the solution of 10^{-1}N $HClO_4$ $G_{Fe^{3+}} = 2.51$ and in 10^{-1}N H_2SO_4 $G_{Fe^{3+}} = 1.04$. The results are discussed in respect to the competitive reactions $Fe^{3+} + H_2O^- = Fe^{2+} + H_2O$ and $H_2O^- + H^+ = H_2O + H$ for the given solutions were calculated. It was observed that ferric ions are reduced by the H_2O^- when the H atoms act as oxidants of the ferrous ions. The reducible form of ferric ions is the $FeOH^{2+}$ complex when Fe^{3+} and $FeSO_4^+$ ions are resistant to the radioinduced reduction. (auth)

37280 PARAMAGNETIC RESONANCE OF DIVALENT LANTHANUM IN IRRADIATED CaF_2. W. Hayes and J. W. Twidell (Oxford Univ.). Proc. Phys. Soc. (London), 82: 330-1(Aug. 1, 1963).

Exposure of crystals of CaF_2 containing La^{3+} ions to ionizing radiations at room temperature produces La^{2+} ions on cubic lattice sites. The La^{2+} ions, which are stable at room temperature for a period of days, are investigated by electron paramagnetic resonance methods. (auth)

37281 HIGH-ENERGY REACTIONS IN STABILIZATION OF Br^{82} HOT ATOMS IN BROMINE ALKYLS. An. N. Nesmeyanov and E. S. Filatov. Radiokhimiya, 5: 378-89 (1963). (In Russian)

The influence of aniline admixtures in bromine alkyls C_3H_7Br, CH_2Br_2, and $CHBr_3$ on the yield and retention of labelled products produced by secondary recoil in Br^{82} (n,γ) reaction was studied. A method was developed for determining the relative proportion of elastic and inelastic interactions in processes delaying Br^{82} recoil atoms. The mechanism of elastic and inelastic interactions was discussed. (R.V.J.)

37282 EFFECTS OF pH ON SORPTION OF Co^{60} BY PEAT. A. I. Berdnikov and V. F. Oreshko. Radiokhimiya, 5: 390-2(1963). (In Russian)

A maximum absorption of Co^{60} by peat was found with pH = 5.8 to 8.0. (R.V.J.)

37283 ELECTRON-MICROSCOPIC STUDIES OF EFFECTS OF ELEMENTARY SULFUR RADIOACTIVITY ON ITS STRUCTURE AND SURFACE. L. I. Zemlyanova, I. E. Zimakov, A. M. Lyapina, Vikt. I. Spitsyn, and N. P. Dobrosel'skaya. Radiokhimiya, 5: 392-4(1963). (In Russian)

Specific surface of radioactive specimens is larger than non-radioactive. The surface of a specimen with specific radioactivity of 100 μc/g is 1.16 m^2/g while for non-radioactive specimen it is 0.57 m^2/g. The obtained data indicated considerable effects of radioactivity on structure and surface of solids. (R.V.J.)

37284 REACTIONS OF TRITIUM RECOIL WITH BENZENE HALOGEN DERIVATIVES. V. V. Pozdeev, An. N. Nesmeyanov, and B. G. Dzantiev. Radiokhimiya, 5: 395-7 (1963). (In Russian)

Reactions of tritium recoil on benzene halogen derivatives were studied in order to determine the influence of chemical bond on tritium recoil reactions. Tabulated data for C_6H_5-Cl, C_6H_5-Br, and C_6H_5-I bond energies indicate that the yield of labeling benzene depends on the bond energy of C_6H_5; the weaker the bond energy the higher the yield of labeling benzene formed by halide atom replacement. It is also shown that molecular iodine does not affect the yield. The yield of labeling products of tritium recoil with fluorobenzene was tabulated and analyzed. (R.V.J.)

37285 POLYMERIZATION OF MONOCHLOROTRIFLUOROETHYLENE INITIATED BY γ-RAYS. M. Lazar and N. Kliman. Vysokomolekul. Soedin., 4: 948-52(1962). (In Russian)

The polymerization of monochlorotrifluoroethylene induced by γ rays from a Co^{60} source at low dosage rates was investigated. A rise in temperature causes a fall in the polymerization rate. The observed negative apparent activation energy is discussed from different standpoints, the most likely cause of this deemed to be degradation transfer of the monomer. (auth)

37286 SPIN 1 CENTERS IN NEUTRON IRRADIATED SILICON. Wun Jung. Thesis, Lafayette, Ind., Purdue Univ., 1963. 145p.

Electron paramagnetic resonance of radioinduced defects in neutron irradiated silicon crystals was studied. Measurements were made as a function of annealing on samples which attained intrinsic resistivity after fast neutron bombardment in a reactor. The measurements were made at temperatures of 300, 77, and 4.2°K, with superheterodyne spectrometers operating at 24 and 9.4 kmc/s. Through analysis of the anisotropy of the resonance spectra, isochronal annealing experiments, and field dependence of the spectra at 24 and 9.4 kmc/s, four spin-1 centers were isolated. The g-tensors and the magnitude of the zero field splitting terms were compatible with systems having a pair of electrons primarily localized in two (111) dangling bond orbitals separated from each other along a (110) direction by a distance of the order of a lattice spacing. The observed resonance arose from the triplet levels produced by a weak exchange interaction. From the low temperature measurements, an upper limit of the triplet-singlet separation was estimated to be 50 cm^{-1}. In view of the distinct symmetry of the spectra and the very small production rate of ~0.05 centers per neutron collision, they probably represent a rather small class of relatively simple, well-defined defects. Each center was observed in comparable concentrations in samples from at least two independent sources, and it appeared unlikely that any impurity other than oxygen was involved. The entire resonance spectrum at 300 and 77°K of intrinsic silicon samples after neutron irradiation near ~50°C was accounted for by centers (II, III) and IX. In crucible-grown samples annealed to higher temperatures after irradiation, the centers reported accounted for the most prominent parts of the spectra; however, at each stage of annealing, perhaps one or two additional centers were present and gave as yet unaccounted lines having amplitudes of up to 30% of the main lines. Some of these lines were very broad and represented substantial concentrations. Vacuum floating zone and crucible grown samples gave substantially identical spectra up to the 250°C annealing stage, showing centers (II, III), IX, and N to be independent of oxygen. At higher annealing temperatures, the rapid and complex sequence of growth and decay of the centers which were observed only in crucible grown samples suggested a role for oxygen, probably as a constituent, and a connection with the coagulation of oxygen in the formation of these centers. Analysis of the hyperfine interaction tensor of center (II, III) showed that a pair of orbitals of 18% 3s and 82% 3p character, each localized at lattice sites and aligned along the same (111) direction account for 56% of the wave function of each electron. (Dissertation Abstr.)

37287 A RADIATION DAMAGE STUDY OF CRYSTALLINE ANTHRACENE. Gerald Ernest Heppell. Thesis, Los Angeles, Univ. of California. 1963. 143p.

The problem of radiation damage brought about in thin anthracene crystals by the bombardment of 5.3-Mev α particles from a Po^{210} source was studied. The damage effect was followed by measuring the decrease in scintillation efficiency. A composite of the theory and experiments supporting the equation of Birks which describes this decrease is presented. The characteristic constant for this efficiency decline was measured. The equation is shown to be reliable as a dose-determining measure for α-particle damage in anthracene. With proper standardization an extension can easily be made to other organic scintillators. The total damage is separated into two classes, nonpermanent (i.e., physical), which arises from lattice dislocations, and permanent (i.e., chemical), which arises from bond breaking. The former is differentiated on the assumption that only it is removable by annealing, a process characterized by an activation energy of 5.2 kcal/mole. Determination of the amount of chemical damage required accurate and reliable measurement of fluorescence spectra. A detailed description is given of the spectrophosphorimeter which was used for these measurements. Modifications, which permit the direct measurement of fluorescence spectra through monitoring the exciting light with a suitable quantum counter solution, permit measurement of excitation and emission spectra of crystals and of concentrated solutions. Absolute fluorescence spectra are obtained by applying the proper correction factor. From the annealing measurements on the solid and from a study of the kinetics of quenching in solution, the amount of physical and chemical damage was determined, and suggestions are made as to the nature of each. (Dissertation Abstr.)

37288 THE ROLE OF IONIC REACTIONS IN THE RADIOLYSIS OF SOLID n-ALKANES. Larry James Kevan. Thesis, Los Angeles, Univ. of California, 1963. 171p.

The mechanism of the chemical effects of ionizing radiation on solid n-alkanes was studied. In the solid state simple considerations indicate that excitation has a minor chemical effect and that many electrons escape from their parent ion radicals which gives the positive ions a significant lifetime. The reactions of these ions then determine the observed products: hydrogen, olefins, and dimers. Solid n-hexane, irradiated with Co^{60} gamma radiation at −196°C, was studied in detail since it was short enough to allow analysis of all of the cross link products (dimers) and hexenes, and long enough to be representative of longer straight chain alkanes. The similarity of the product yields from solid n-hexane to those from solid n-pentane through n-nonane and even polyethylene at room temperature is evidence for the generality of the mechanism presented. The results show that the active species is the original ion radical produced by the ionizing radiation and the ion radical reacts before relaxing to distribute the positive charge or to isomerize in any way and thus forms three different ions with a localized charge on carbon atoms one, two, or three. The ion radical reacts with nearest neighbor groups to bond and release H_2, thereby forming olefins by

reaction with neighboring carbon atoms in the same molecule four times out of five, and dimers by reaction with neighboring molecules one time out of five. The principal mechanism of the fast interaction of the primary ion with a neutral CH_2 group was the direct formation of a new carbon-carbon bond and the elimination of H_2. The second most important mechanism was considered to be the abstraction of a hydrogen atom from a neighbor group by the ion to form the electronically saturated analog of CH_5^+ which when neutralized eliminates H_2 and leaves a free radical to combine with the neighboring free radical left by the hydrogen atom abstraction. The cage repression of fragmentation was an important feature of the solid phase radiolysis. Charge or electron transfer in the solid also appeared to be a significant process when atoms or compounds were present that made it energetically possible. These included the radiolytic products: hexenes and dimers. In a 50/50 mol % mixture of argon and n-hexane irradiated at −196°C, 80% of the ionized argons underwent charge transfer to the n-hexane, and the ion radical reacted chemically to form its dimers or the hexenes. Other charge transfer effects were seen in pure solid n-hexane at −196°C and in the liquid at −78°C. (Dissertation Abstr.)

37289 THE KINETICS OF RADIATION-INDUCED GRAFT POLYMERIZATION. Horace W. Chandler. Thesis, New York, Columbia Univ., 1963. 163p.

The kinetics of radiation-induced grafting of pure styrene, pure acrylonitrile, and mixtures of the two to polyethylene were studied. In particular, the effect of the following factors on the kinetics was investigated: film thickness, composition of monomer mixture, dose rate, and temperature. Auxiliary experiments to determine the equilibrium distribution of the monomers between the liquid phase and the swollen polymer phase were performed. Experiments were also performed to determine the value of the diffusion coefficients for pure styrene and pure acrylonitrile in polyethylene. The ternary phase distribution data for the system styrene, acrylonitrile, polyethylene were correlated using a method developed by Krigbaum and Carpenter. The rate of grafting of mixtures of styrene and acrylonitrile goes through a maximum as the composition of the mixture changes, the position of the maximum varying as the film thickness changes. The calculated value of k_p^2/k_T for the grafting of styrene to polyethylene at 27°C is approximately 10^3 times as great as the value obtained in the homogeneous polymerization of styrene, indicating that the value of the termination-rate constant is smaller in the grafting reaction than in the homogeneous polymerization. In addition, copolymer composition data indicated that the propagation-reaction-rate constant is also lower for the grafting reaction than it is for the homogeneous polymerization. (Dissertation Abstr.)

37290 BASIC CONCEPTS OF NUCLEAR CHEMISTRY. Ralph T. Overman. Selected Topics in Modern Chemistry. New York, Reinhold Publishing Corp., 1963. 125p. $1.95.

Information is presented on concepts of atomic and nuclear structure, interactions of radiations with matter, detection and measurement of nuclear radiations, decay laws and statistical probability, and applications of nuclear chemistry. (P.C.H.)

Raw Materials and Feed Materials

37291 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF URANIUM METAL. James Elgie Lloyd and Donald Duxbury (to United Kingdom Atomic Energy Authority). British Patent 933,436. Aug. 8, 1963. Filed Jan. 22, 1959.

A process for the production of U metal by reduction of uranium tetrafluoride with Mg metal is patented. The reactants are compacted to raise the bulk density of the charge and then heated in a reaction vessel in 2 consecutive stages. In the first stage, which occupies the major part of the total heating period, the reactants are heated to a temperature below the temperature of initiation of the reaction, and the reaction vessel is evacuated. In the second stage, heating is continued under a blanket of inert gas to the temperature of initiation of the reaction. The gas may be Ar at a pressure of 10 to 15 lbs above atmospheric pressure. The process produces cleaner U metal with less slag inclusion. (M.P.G.)

Separation Processes

37292 (ORNL-TM-586) CHEMICAL TECHNOLOGY DIVISION. UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, MARCH 1963. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Sept. 20, 1963. Contract W-7405-eng-26. 40p.

Batch leaching tests of sheared pieces of a fuel assembly of ThO_2-UO_2 clad in stainless steel were made. Difficulty in suspending the fines increased the time required for dissolution and obscured the results of tests to determine the effect of splitting the dissolvent into two charges. The efficiency of a pulsed sieve-plate column used for the scrub section of the Tramex flowsheet was only slightly improved by insertion of several types of coalescers spaced throughout the column. Corrosion of INOR-8 and Alloy 79-4 specimens, and the Mark II INOR-8 vessel was measured during five dissolution-fluorination cycles and after decontamination with $Al(NO_3)_3-HNO_3$. Half times for uranium removal during fluorination of $ZrF_4-NaF-LiF-UF_4$ were 38 and 30 minutes at F_2 flows of 1.5 and 2.2 slm, respectively. High-level waste processing run R-73, using simulated Purex-65 waste containing 0.01 ml per liter of a 50% mixture of MBP and DBP, showed no abnormality because of the organic. Severe corrosion of the calciner pot occurred which was probably caused by high fluoride (0.007 M) in the feed. (auth)

37293 (ORNL-TM-682) STACKED CLONE CONTACTOR DEVELOPMENT: MARK I. W. E. Dunn (Oak Ridge National Lab., Tenn.). Sept. 12, 1963. Contract [W-7405-eng-26]. 21p.

A stacked clone contactor, which decreases the time of contact between the organic solvent and radioactive materials in solvent extraction processing, was developed. In flooding and holdup studies with kerosene and 0.08M HNO_3, at an A/O volume ratio of 1 the total flooding throughput was 1.1 liter/min. This corresponds to a solvent holdup time of approximately 4 sec per mechanical stage. Stage efficiencies for A/O's from 1.0 to 3.5 and 32 to 85% flooding varied from 20 to 75%. The extraction system used to evaluate the contactor was: benzoic acid-Supersol-0.078M HNO_3. Equilibria for this system were found to be represented by $y = (0.0924 \pm 0.0081)x^2 + (2.40 \pm 0.21) \times 10^{-6}x^4$ where y and x are, respectively, the organic and aqueous benzoic acid concentrations. Several extraction runs were completed in which Amsco was used as the solvent instead of Supersol. (auth)

37294 (AEC-tr-6014) SEPARATION OF Zr^{95}, Nb^{95}, AND Ru^{106} FROM MIXED FISSION PRODUCTS BY EXTRACTION WITH TRIBUTYL PHOSPHATE. N. E. Brezhneva, V. I. Levin, G. V. Korpysov, E. K. Bogacheva, and N. M. Manko. Translated by C. E. Stevenson (Argonne

National Lab., Ill.), from At. Energ., 15: 23-9(June 1963). 13p.

Results are presented concerning studies of obtaining the radiochemically pure isotopes Zr^{95}, Nb^{95}, and Ru^{106} by the general scheme described earlier for the distribution of small quantities of radioactive elements. There is described an important form of the principles which are derived and established by studying the extraction of zirconium, niobium, and ruthenium by tributylphosphate. The extraction of ruthenium by TBP is carried out after preliminary concentration on metallic sulfides. The separation of niobium and zirconium is accomplished by means of successive re-extraction of niobium with hydrogen peroxide and zirconium with oxalic acid. (auth)

37295 (EURAEC-665) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 12, January 1–March 31, 1963. (Mol, Belgium. Centre d'Etude de l'Energie Nucléaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 098-62-11RDB. 41p. A translation.

The use of Ce and Cd chlorides for selective fixation of fission products is studied. Hydrofluorination of UO_3 and U_3O_8 is studied. Studies of the $UO_2 \rightarrow U_3O_8 \rightarrow UO_2F_2 + UF_4 \rightarrow UF_6$ and UO_2(or UC) $\rightarrow UO_3 \rightarrow UF_6$ cycles are reported. Experiments on the oxidation of UF_4, dissolved in LiCl–KCl eutectic melts, into UO_2 by bubbling O_2 through the melt are carried out. (T.F.H.)

37296 NATURE OF THE HYDROGEN ION EFFECT ON THE EXTRACTION OF Co(II) FROM AQUEOUS CHLORIDE MEDIA BY SUBSTITUTED AMMONIUM CHLORIDES OF HIGH MOLECULAR WEIGHT. M. L. Good, S. E. Bryan, F. F. Holland, Jr., and G. J. Maus (Louisiana State Univ., New Orleans). J. Inorg. Nucl. Chem., 25: 1167-73 (Sept. 1963). (In English)

The phenomena associated with the decreased extraction of certain metals [particularly Co(II)] from concentrated HCl solutions by organic solutions of high-molecular-weight, substituted ammonium chlorides were investigated. The spectra of the metal species in both the aqueous and organic phases for both LiCl and HCl systems were determined, indicating no spectral differences in the species extracted from the two systems. The extraction process was studied as a function of the HCl concentration and infrared spectra of the organic phase containing extracted HCl were obtained. Extraction isotherms for the extraction of the metal ion from 12M HCl and 12M LiCl were compared. The results show that at high aqueous HCl concentration, the substituted ammonium chloride solutions extract excess HCl, probably in the form of the hydrogen dichloride ion with excess hydrogen-bonded molecular HCl. A possible conclusion from this study is that the exchange equilibrium for the extraction of the cobalt anion is displaced by the reaction of the substituted ammonium chloride with the excess HCl, thus reducing the extractability of the metal. (auth)

37297 APPLICABILITY OF CERTAIN ORGANO PHOSPHORUS EXTRACTANTS TO ENVIRONMENTAL AND BIOLOGICAL RADIOACTIVITY SURVEYS. D. F. Peppard, G. W. Mason, and C. M. Andrejasich (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 25: 1175-89(Sept. 1963). (TID-18369; UAC-7209). (In English)

The applicability of certain organo-phosphorus extractants to environmental and biological radioactivity surveys was demonstrated. Specifically, a solution of mono-2-ethylhexyl phosphoric acid, H_2MEHP, in a hydrocarbon and/or chlorinated hydrocarbon diluent was shown to extract radioactive Ce(III), Pm(III), Y(III), Am(III), Pu(III), Th(IV), Np(IV), Pu(IV), and U(VI) from acidified human urine with sufficiently high K values to permit basing a scheme of analysis for such radioelements upon liquid-liquid extraction. The specific K value is strongly dependent upon the valence of the element, permitting a partial mutual separation of the above set of elements through use of the H_2MEHP (hydrocarbon and/or chlorinated hydrocarbon) vs. HCl system. These separation possibilities are multiplied by introduction of negative synergist, specifically 2-ethyl hexanol-1, which serves to progressively inactivate H_2MEHP. Consequently, under certain conditions, M(III) may be scrubbed from an extract leaving M(IV) and M(VI) in the organic phase; but under another set of conditions involving a greater relative concentration of negative synergist, M(VI) may be scrubbed from the extract leaving M(IV) in the organic phase. Further mutual separation is accomplished by means of extraction with di-2-ethylhexyl phosphoric acid, HDEHP. This extractant serves to separate Y from Pm, Ce(III), and Am and to separate Ce(IV) from Pm and Am. Finally, extraction with tri-n-octyl phosphine oxide, TOPO, is utilized in the separation of U(VI) from Pu(III). Through use of selected diluents of different densities, the organic phase was made the upper or lower phase in accordance with maximum ease of manipulation. Flow sheets were devised and tested. Advantages of the techniques are discussed, and other areas of application are suggested. (auth)

37298 EXCHANGE PROPERTIES OF AMMONIUM SALTS OF 12-HETEROPOLYACIDS. V. SORPTION OF ALKALI METALS ON AMMONIUM PHOSPHOMOLYBDATOTUNGSTATE. J. Krtil and I. Křivý (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). J. Inorg. Nucl. Chem., 25: 1191-3(Sept. 1963). (In English)

The exchange properties of ammonium salts of phosphomolybdatotungstic acid (NH_4PMoW) with various molar ratios of Mo:W are described. The uptake of cesium and rubidium is shown. Good separation was obtained. (M.C.G.)

37299 ADSORPTION STUDIES ON CLAY MINERALS. VIII. A CONSISTENCY TEST OF EXCHANGE SORPTION IN THE SYSTEMS SODIUM–CESIUM–BARIUM MONTMORILLONITE. Russell J. Lewis and Henry C. Thomas (Univ. of North Carolina, Chapel Hill). J. Phys. Chem., 67: 1781-3(Sept. 1963).

Standard free energies of exchange from solutions of the chlorides at 0.04N on a purified montmorillonite clay were determined for the three reactions: Cs → Na, –2152 cal/mole; Ba → 2Na, –496 cal/mole; and 2Cs → Ba, –3677 cal/mole. These satisfy the requirement of additivity. Activity coefficients are given as functions of surface composition. (auth)

37300 PROCESSING OF IRRADIATED URANIUM DIOXIDE FUEL BY CHLORINATION-DISTILLATION. Takehiko Ishihara and Kenmei Hirano (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 549-54(July 1963). (In English)

Using the difference in vapor pressure between the chlorides of uranium and those of fission products, a chlorination-distillation process of irradiated uranium dioxide fuel was investigated. The experiments were carried out with the chlorination agent CCl_4 vapor flowing through a quartz reaction tube assembly at various reaction and condensation temperatures. On a single distillation, about 80% of the uranium was recovered and about 90% of the γ-emitting fission products was separated from the uranium. Main nuclides condensed together with the ura-

nium were Ce^{141} and Ce^{144}. For the purpose of improving the decontamination of uranium, natural CeO_2 was mixed with the irradiated UO_2 to the extent of 1% before chlorination. About 97% of the fission products was separated from the uranium, and Ru^{103}, Ru^{106}, Cs^{137}, and Nd^{147} remained as the residue. (auth)

37301 REPROCESSING OF UO_2-DISPERSED GRAPHITE FUEL. III. STUDIES ON CHLORIDE VOLATILITY PROCESSING. Kazumi Iwamoto, Fumiaki Kobayashi, and Junichi Shimokawa (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 560-6(July 1963). (In English)

The chloride-volatility process was applied to the processing of irradiated UO_2–graphite fuel elements, in which most of the fission products were introduced into the graphite matrix by fission recoil. In proper conditions, 99% of the UO_2 in the sample was chlorinated with CCl_4 vapor. The major objective of the study was to investigate the behavior of fission products during chlorination. It was elucidated that besides the postirradiation heating itself the existence of the chlorinating agent was additionally effective in the migration of fission products in the graphite matrix. The possibility of low-temperature chlorination with chlorine gas was also studied. (auth)

37302 SOLVENT EXTRACTION BEHAVIOR OF INORGANIC IONS IN THE ALKYLAMINE-HYDROCHLORIC ACID SYSTEM — PRIMENE JM-T. Tomitaro Ishimori (Japan Atomic Energy Research Inst., Tokyo), Kan Kimura, Eiko Nakamura, Wen-Pin Cheng, and Reiko Ono. Nippon Genshiryoku Gakkaishi, 5: 566-71(July 1963). (In English)

The solvent extraction behavior of about 60 elements was surveyed in the system of 10 vol. % Primene JM-T xylene solution vs. hydrochloric acid, in which the acidity was varied from 1 to 12N. The distribution ratio, K_d, of a particular nuclide was determined by the use of a radioactive tracer. The K_d values of this Primene JM-T-HCl system were usually below one. Iron, gallium, antimony, and protactinium were extractable above 6N hydrochloric acid, while gold alone could be extracted all over the hydrochloric acidity tested. The results were compared with those for secondary or tertiary amine extraction. (auth)

37303 SOME MECHANISMS OF EXTRACTION OF M(II), (III), (IV), AND (VI) METALS BY ACIDIC ORGANOPHOSPHORUS EXTRACTANTS. D. F. Peppard and G. W. Mason (Argonne National Lab., Ill.). Nucl. Sci. Eng., 16: 382-8(Aug. 1963).

In general, the mono-acidic phosphates and phosphonates are dimeric and the di-acidic phosphates and phosphonic acids are polymeric in the diluents commonly employed in metal extraction studies. Therefore, they may be symbolized, respectively, as $(HY)_2$ and $(H_2Y)_x$. The extraction of tracer-level M(III) actinides and lanthanides from a dilute mineral acid by representatives of these two classes of extractants in toluene diluent may be represented, respectively, as: $M_A^{+3} + 3(HY)_{2O} \rightleftharpoons M(HY_2)_{3O} + 3H_A^+$ and $M_A^{+3} + (H_2Y)_{x_O} \rightleftharpoons M[H_{2x-3}Y_x]_O + 3H_A^+$ where the subscripts A and O refer to mutually equilibrated aqueous and organic phases. However, in an alcohol diluent the H_2Y extractants appear to be monomeric, and they extract M^{+3} cations with a third-power extractant dependency. In toluene diluent, the HY extractants function as dimers, the extractant dependencies for selected M^{+2} and M^{+4} cations being: UO_2^{+2} (2-power); Ca^{+2}, Sr^{+2}, Ba^{+2} (2.5-power, 3-power); Th^{+4} (3-power). In certain systems, Th^{+4} is extracted as a species containing one or two nitrate groups. Structures of the extracted species are postulated. (auth)

37304 ALKYLPHOSPHORIC ACIDS AND THEIR COMPLEXES WITH METALS. C. J. Hardy (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Nucl. Sci. Eng., 16: 401-4(Aug. 1963).

The extraction of metals and acids from aqueous solution by alkylphosphoric acids and the basic equilibria involved are discussed. The solubility and distribution of mono- and di-n-butyl phosphoric acid (H_2MBP and HDBP respectively) were measured in various aqueous-organic solvent systems — in particular the TBP–kerosene–HNO_3 system. The data for HDBP can be interpreted in terms of a series of equations for the dissociation of the HDBP in the aqueous phase, the dimerization of the HDBP in the aqueous phase, the association of HDBP with TBP and with nitric acid, and the distribution of the HDBP monomer and dimer, and the HDBP·HNO_3 complex, between the phases. Nitric acid and water are extracted by dialkylphosphoric acids and also by the commonly used diluents. Nitric acid is extracted by HDBP in toluene or kerosene largely as the HDBP·HNO_3 complex, which is in equilibrium with the hydrated complexes HDBP·H_2O and HDBP·HNO_3·H_2O. Metals are extracted from aqueous solution by dialkylphosphoric acids (HX) mainly in four forms containing as ligands: X groups, X and HX groups, X and HX groups and also the anion, for example, NO_3^-, present in the initial aqueous solution, and HX groups and the anion in the aqueous phase. The occurrence of one or more of these types of complex is illustrated for U(VI), Zr(IV), and Be(II). (auth)

37305 THE SYNERGISTIC EFFECTS IN ORGANOPHOSPHATE EXTRACTION SYSTEMS. C. F. Baes, Jr. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 16: 405-12(Aug. 1963).

Combinations of dialkylphosphoric acids (HA) and neutral organophosphorus reagents (B) were for some time known to produce enhanced (synergistic) extraction of UO_2^{+2} and other MO_2^{+2} actinide ions. This effect may be attributed to the formation of a mixed complex — either a substitution product MO_2A_3HB or an addition product $MO_2A_4H_2B$ resulting from the reaction of B with the extraction complex $MO_2A_4H_2$ normally formed with HA alone. Available extraction data, when analyzed in terms of the competing hydrogen-bonding interactions between HA and B, appear more consistent with an addition product $MO_2A_4H_2B$. The stability of this mixed complex as a function of the neutral organophosphate used and as a function of the diluent used is consistent with hydrogen bonding or solvation of $MO_2A_4H_2$ by B. The much stronger and more general synergism found in systems wherein HA is replaced by the β-diketone, Thenoyltrifluoroacetone (HY) may be attributed to the relatively weaker competing interaction between HY and B and to the less coordinatively saturated extraction complexes formed by HY alone. (auth)

37306 SYNERGISM WITH THENOYL TRIFLUOROACETONE IN THE SOLVENT EXTRACTION OF METALLIC SPECIES. T. V. Healy (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Nucl. Sci. Eng., 16: 413-20(Aug. 1963). (AERE-R-4191)

Thenoyl trifluoroacetone (HTTA) was used as the acid in combination with neutral organophosphates (S) to demonstrate a strong (synergistic) enhancement of extraction of metallic species. This enhancement using HTTA is exhibited by many metal species and is much larger (up to 10^6) than that obtained with the dialkyl phosphoric acids (up to 10^2). This effect is increased as S is changed from the neutral alkyl phosphates, through phosphonates, to the phosphine oxides. Examples of synergism with HTTA and

S are also given where S, the neutral additive, contains no phosphorus and is an amide, alcohol, or ketone. Tracer work has established the composition of over 30 extracting species containing di, tri, and tetravalent metals of the general formula $M(TTA)_xS_y$, where x is the valency of M, and y varies between 1 and 3. Confirmation of these formulas was, in a number of instances, obtained by ultraviolet spectrophotometry on tenth molar solutions and by analysis of anhydrous microcrystalline solids isolated from solution. Stability constants were also ascertained for many of these synergistic species. Infrared work indicates the likelihood of some of the chelate ligands becoming monodentate in the synergistic species with direct bonding of S to the metal. If an excess of neutral ester S is added to a synergistic system, antisynergism, that is the reverse of synergism, occurs and decreases of 10^8 in extraction coefficient can occur. The degree of antisynergism depends on the quantity and nature of S. S could be an alcohol, amide, ketone, ether, ester (including organophosphorus esters) or, in fact, a so called inert diluent such as benzene or chloroform. The cause of these very large antisynergistic effects is bound up with the water content of the neutral additive S and of the diluent. There is ultraviolet spectral evidence that the anhydrous species is destroyed with formation of a hydrated TTA species. (auth)

37307 EXTRACTION OF METAL NITRATES BY TBP · HNO_3. J. M. Fletcher and C. J. Hardy (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Sci. Eng., 16: 421-7(Aug. 1963).

The extraction by TBP of nitrato complexes of metals occurs mainly by the formation of nonconducting complexes in which the oxygen of the PO group is covalently bound to the metal, e.g., $P=O \rightarrow M$. In other TBP complexes, this O atom is bonded to hydrogen, e.g., to a hydrogen atom of water, of an undissociated acid, or of the hydronium ion. Three features in the extraction of metal nitrates at trace concentration from nitric acid concentrations >7M which await interpretation are the second increase in the distribution coefficient, D_M; the decrease in the magnitude of this second increase as the fraction of inert diluent increases; and the change in the temperature coefficient of D_M from negative to positive. Extraction by bonding of the phosphoryl oxygen to an aquo group (of the aquonitrato metal complex), or by nitrato acids, do not explain these features. Measurements of the conductivity and viscosity of 100% TBP-HNO_3-H_2O phases are consistent with the existence of three steps as the ratio HNO_3/TBP increases. In the first step, ions, postulated as $(TBP \cdot H_3O \cdot H)_3O^+$ and $(TBP \cdot H)_2(H_2O \cdot H)O^+$, are formed. In the second step, the molar conductivity decreases as the predominant species becomes TBP · HNO_3. In the third step the molar conductivity and the water content increase by the formation of ions such as $(TBP \cdot H)(H_2O \cdot H)(HNO_3 \cdot H)O^+$, in which a nitric acid molecule is bonded to the hydronium ion: the second increase in D_M for certain metals is explained by there being similar bonding, through the oxygen of a nitrato group of the metal complex, in place of the HNO_3 in this complex ion when HNO_3/TBP is >1. The positive temperature coefficient shown by this form of extraction of metal nitrates is also shown in this region by the extraction of nitric acid, the conductivity, and the water content. (auth)

37308 THE NEUTRAL ORGANOPHOSPHORUS COMPOUNDS AS EXTRACTANTS. L. L. Burger (General Electric Co., Richland, Wash.). Nucl. Sci. Eng., 16: 428-39(Aug. 1963).

The neutral organophosphorus derivatives: phosphines, phosphine oxides, phosphinates, phosphonates, and phosphates are briefly reviewed. All form metal complexes and all except perhaps the first were studied in some detail in connection with solvent extraction. The physical and chemical properties of these compounds are considered as is the mechanism of extraction for acids and metal salts. Most extractions are straightforward consisting of hydrogen bonding for acids and solvation for neutral salts. The strength of these complexes can often be correlated with infrared or nuclear magnetic resonance shifts. Metals display a wide range of extractibility depending on the reagent (solvent and diluent), the aqueous anion, the water activity, and the acidity. Selective extraction is often found for nitrate, perchlorate, perhaloacetate, and some chelating acid salts. Because of the relative simplicity of the solvation complexes and the variability in the solvent strength of the different phosphorus esters, several attempts at thermodynamic studies of the extraction process were made. Rigorous treatment of most systems is seen to be difficult and the results were only moderately satisfactory. Some recent work is discussed. For large scale uranium–plutonium processing, tributyl phosphate is firmly entrenched. Several alternatives were considered including both alkyl and phenyl phosphonates. For small-scale applications and for analytical separations the more expensive phosphinates and phosphine oxides may be useful. (auth)

37309 EXTRACTION WITH SULFUR-CONTAINING ORGANOPHOSPHORUS COMPOUNDS. Thomas H. Handley (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 16: 440-7(Aug. 1963).

The solvent-extraction properties of the sulfur analogs, both neutral and acid, of those organophosphorus compounds that were used so extensively in solvent extraction were investigated. These sulfur analogs have one or more oxygen atoms replaced by sulfur atoms. The neutral esters, trialkyl phosphorothioates, selectively extract Ag^+ and Hg^{2+} from a nitric acid medium. In general, the acid esters, dialkyl phosphorothioic and -dithioic acids, extract from mineral acid solutions those metal ions that form insoluble sulfides. Dialkyl phosphorothioic acids appear to be more selective extractants than are the corresponding dithioic acids. The effects of various organic solvents, of concentration of mineral acid, and of concentration of dialkyl phosphorothioic and -dithioic acids were studied. The relative order of extraction and the limits of extraction were determined. The nature of the zinc di-n-butyl phosphorothioate and -dithioate complexes as they exist in the aqueous and organic phases were investigated. (auth)

37310 EXTRACTION OF THORIUM WITH BENZOHYDROXAMIC ACID. Abdel Gavad Saed, A. V. Lapitskii, and N. P. Rudenko. Radiokhimiya, 5: 290-4(1963). (In Russian)

A maximum extraction of thorium by hexanol in benzohydroxamic acid was achieved at pH = 5.2. The extraction method was also used to determine the structure of the thorium compound with benzohydroxamic acid $Th(NO_3)_4 \cdot 2\,HR$. (R.V.J.)

37311 THE SEPARATION AND PURIFICATION OF YTTRIUM EARTHS ON ION EXCHANGERS WITH THE HELP OF A "TWO-STAGE SEPARATION METHOD." W. Noddack and J. Woidt (Staatliches Forschungsinstitut für Geochemie, Bamberg, Ger.). Z. Anorg. Allgem. Chem., 323: 209-19(July 1963). (In German)

Mixtures of rare-earth oxides in amounts of 2 to 10 kg were separated by an ion exchange method in two steps. In column runs, some optimal conditions for the separation

of rare earths could be obtained by the exchange resin "Lewatit S 100" by means of "Trilon AO" (sodium nitrilotriacetate) as a complexon. Large amounts of pure rare-earth oxides, especially of those with odd atomic numbers, resulted. A separation scheme for "Gadolinite" is described. (auth)

37312 ON THE INFLUENCE OF ACIDITY OF THE ELUTION AGENT ON THE SEPARATION EFFECT FOR THE SEPARATION OF YTTRIUM EARTHS ON ION EXCHANGERS. W. Noddack and W. Korneli (Staatliches Forschungsinstitut für Geochemie, Bamberg, Ger.). Z. Anorg. Allgem. Chem., 323: 220-7(July 1963). (In German)

To increase the efficiency of the ion exchange method for the separation of rare-earth oxides in large amounts, the influence of the acidity of complex-forming agents on the separation effect was investigated. The obtained optimum conditions allowed the development of a gradient elution method, the results of which are comparable with those of separations in two or more steps. (auth)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstracts 38456 and 38458.

37313 (JAERI-5009) DESIGN AND CONSTRUCTION OF THE HOT LABORATORY. (Japan Atomic Energy Research Inst., Tokyo). 1963. 105p. (In Japanese)

Construction of a hot laboratory for handling highly radioactive materials such as reactor fuel elements and structural components irradiated in reactors was started in 1959. The laboratory consists of two sections, metallurgical and chemical, and contains metallurgical and chemical hot caves, and analytical and semi-hot cells. The metallurgical hot cave is composed of four cells in a row with shielding capacities of 2,000 to 10,000 Mev-curies, and the chemical hot cave has two cells with 10,000 Mev-curie capacity. Both are shielded with 1 m thick high density concrete walls. The analytical cells are arranged in two rows with seven in each row, with 15-cm-thick lead-brick shielding. The semi-hot cells are of the self-standing type with 10-cm-thick lead-brick shielding. Seven analytical cells and three semi-hot cells are completed. Details of the design and construction of the building and caves including auxiliary facilities and equipment are described. (auth)

37314 (NP-13100) SIZE FRACTIONATION: AN ANNOTATED BIBLIOGRAPHY. Jack B. Goldmann, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Apr. 1963. Contract NOw 60-0738-D. 18p. (SB-63-40)

Forty-four references on size fractionation by elutriation technique (liquid and gas) are given to U. S. and foreign journals published from December 1949 through 1962. Emphasis was placed upon the fractionation of ultrafine powders (range: 0.8 to 1.2μ). A separate author index is included. (P.C.H.)

37315 (NYO-10149) STRESSES AT NOZZLE CONNECTIONS OF PRESSURE VESSELS. PART II. EFFECT OF COMBINED LOADING CONDITIONS. Period Covered: January 1, 1962–September 30, 1962. D. E. Hardenbergh, S. Y. Zamrik, and A. J. Edmondson (Pennsylvania State Univ., University Park). Jan. 16, 1963. Contract AT(30-1)-1874. 34p.

The effects of extraneous loads applied to the branch pipe upon the stress pattern already present in a nozzle due to internal pressure were investigated. For comparative purposes, a contoured outlet and an insert type nozzle were selected for this study. (auth)

37316 (TID-16966) HIGH PRESSURE PUMP SEAL DEVELOPMENT. Status of Tasks II, III, IV, V, VI, and VII. Engineering Monthly Progress Report, September 1962. R. C. Hajner (Worthington Corp. Advanced Products Div., Newark, N. J.). Oct. 11, 1962. Contract AT (30-1)-2683. 30p.

All of the material compatibility tests which were conducted during this report period utilized the type IIB model seal configuration. The tests were carried out at pressures of 4,000 psig. The leakage flow rates and shaft speeds were varied from 1.5 to 0.4 gph and 900 to 3600 rpm. At 2000 psi and 2 gph, a large variety of seal face combinations performed satisfactorily for several hours. By doubling the pressure and reducing leakages it was possible to select the best combination without incurring the time and expense for long test periods. A total running time of 48 hours was accumulated for these test conditions. The seal face material combinations tested were:

Rotor		Stator
(1) Kennametal K-96	vs.	Bearium B-11
(2) Coors Aluminum Oxide	vs.	Bearium B-11
(3) Nucerite Coating	vs.	Bearium B-11

The results of the test showed that the second combination was the best and the first combination was second best. The third combination performed equally well as the first two at the higher leakage rates. At lower leakage rates, however, this combination failed. Several successful tests were conducted in the model test rig up to pressures of 4000 psig, using a Bearium B-11 face material which was epoxy bonded to an Armco 17-4PH steel backing piece. (auth)

37317 (TID-17608) HIGH PRESSURE PUMP SEAL DEVELOPMENT STATUS OF TASKS II, IV, V, VI AND VII. Engineering Monthly Progress Report, October 1962. R. C. Hajner (Worthington Corp. Advanced Products Div., Newark, N. J.). Contract AT(30-1)-2683. 17p.

Material-compatibility tests were conducted on the model seal test rig. One test was used to evaluate an aluminum oxide rotor running against a tungsten carbide stator. The test was run for 19$\frac{3}{4}$ hours at a pressure of 4,000 psig and at a leakage flow rate of 1.26 gph. The seal face materials were optically checked before and after the test. The change in flatness on both faces was estimated at about one light band. In another test the rotor material was aluminum oxide and the stator material was Bearium B-11 with a Bearium B-11 sealing element. This combination failed after operating for five minutes. The cause of failure was attributed to an intermittent leakage past the seal. In a third test, the same rotor and stator materials were used as in the second test, except that the seal had a Graphitar 39 sealing element. This test was terminated after 34 hours of successful operation at a pressure of 4,000 psig and at a leakage flow rate of 1.58 gph. An optical check of the seal faces before and after the test showed a dimensional change pattern of less than one light band for both parts. The instrumentation and control system planned for the full-size seal test loop were shown. (auth)

37318 (TID-17704) MISALIGNMENT SIMULATION WITH ECCENTRIC DIAMETERS IN AN AUTOCLAVE. George A. Hill (Knolls Atmoic Power Lab., Schenectady, N. Y.). Jan. 4, 1963. Contract W-31-109-eng-52. 11p.

Any complex assembly of many parts involves the problem of possible misalignment due to tolerances, pressure, and temperature. In order to study this problem, it is often desirable to perform a proof test of the components with various possible misalignments at high pressure and temperature. A description is given of a Misalignment Basket, which was constructed for misalignment testing of a complex assembly in an autoclave. It uses a control eccentric diameter and bolt holes to allow the accurate resetting of the misalignment. (D.L.C.)

37319 THE APPLICATION OF ADVANCED PROPULSION SYSTEMS TO DEEP-SPACE VEHICLES. R. G. Cruddace (Ministry of Aviation, Rocket Propulsion Establishment, Westcott, Bucks, Eng.). J. Brit. Interplanet. Soc., 19: 133-47(July-Aug. 1963).

An analysis is developed for optimizing the exhaust velocity variation of an electric propulsion system so as

to obtain the maximum payload fraction. Using the results of this analysis, electric propulsion systems are compared to thermal systems for three important classes of deep-space mission; the adjustment of Earth satellite orbits; lunar missions; and interplanetary missions. (auth)

37320 SYSTEM CONSIDERATIONS OF ELECTRIC PROPULSION FOR NEAR-EARTH MISSIONS. M. J. Russi and W. H. Lien (Aerospace Corp., El Segundo, Calif.). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63006, 38p. (CONF-10-34)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

The results of a preliminary investigation of electric propulsion for near-earth missions and functions are presented. The performance and cost advantage of electric propulsion over relatively simple chemical propulsion does not appear to be sufficient to warrant its use for delivering a nuclear powerplant to 24-hour equatorial orbit. Electric propulsion does not appear to be competitive with other propulsive and non-propulsive methods for providing satellite limit cycle attitude control since the impulse requirements for this function are quite small. If the need for low-altitude orbit sustaining can be established, the impulse requirements over a long period of time are sufficiently high that nuclear electric propulsion offers substantial savings in system weight and cost compared to chemical propulsion. (auth)

37321 INVESTIGATION OF ELECTRICAL SYSTEMS OF PLASMA ARC JET ENGINES. Robert Richter (General Electric Co., Cincinnati). New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63044, 44p. (CONF-10-52)

From Electric Propulsion Conference, Colorado Springs, Colo., Mar. 1963.

A discussion of the operation of plasma arc jet engines is presented. It is pointed out that when operating a-c arcs at least three types of stability have to be considered: stability with respect to operating point, stability with respect to arc operation, and stability with respect to system oscillation. The stability with respect to operating point is briefly reviewed, and the analytically determined minimum electrical component values for stabilizing d-c, single-phase a-c, and three-phase a-c are presented. The results are applied and experimentally obtained arc characteristics. It is pointed out that the analytically determined values have to be considered optimum values which are insufficient for the actual arc operation. The two instabilities which are characteristic of the a-c arc only, that is, stability with respect to arc operation and stability with respect to system oscillation, are presented by citing experimentally found interdependences between arc operation and electrical component values. Experimental techniques for starting a three-phase plasma arc jet engine are presented. A correlation is found between the size of electrical components in the arc circuit and the starting conditions with respect to flow rate and open circuit voltage. (auth)

37322 THE SOLAR POWER SUPPLY SYSTEM FOR THE ORBITING ASTRONOMICAL OBSERVATORIES. Carl J. Wenzinger (Goddard Space Flight Center, Greenbelt, Md.) and Henry Carleton. New York, American Inst. of Aeronautics and Astronautics, 1963, Preprint 63-127, 10p. $1.00. (CONF-97-18)

From Summer Meeting, Los Angeles, June 1963.

The power subsystem of the Orbiting Astronomical Observatory (OAO) is required to supply all electrical power for the spacecraft equipment and for its experiments for a period of one year in orbit. Included in the system are equipment for regulation, conversion, inversion, distribution, and power protection. The solar cells used in the OAO consist basically of an n-type Si wafer onto which a p-type B layer is diffused. The solar array has approximately 31,000 cells mounted on the front sides and a similar number on the rear sides of the solar panels. A programmed computer analysis indicated that the average of the maximum power output of the array was always higher than the averaged power required by the load. Addiation of an extra 10,000 solar cells may be necessary to compensate for damage from the new radiation belt caused by high-altitude nuclear explosions. (A.G.W.)

37323 A VIEWPOINT ON SPACE PROPULSION AND POWER-GENERATION SYSTEMS. John C. Evvard (Lewis Research Center, Cleveland). 24p. (CONF-132-1)

From Fourth International Symposium on Space Technology and Science, Tokyo, Aug. 1962.

The propulsion system paces man's effectiveness in space. The choice of the best propulsion system to accomplish a space mission depends strongly on space environmental factors as yet insufficiently evaluated. The minimum metal thickness necessary to achieve a required meteoroid damage survival probability is still uncertain. The two most obvious possibilities for greater propulsion capabilities than the chemical rocket are the nuclear rocket and electric propulsion. The electric plant must eliminate its waste heat in a large space radiator, which must be reasonably puncture-proof in the statistical meteoroid environment of space. Because of present uncertainty about meteoroid penetration and because the nuclear rocket does not have the radiator problem, it is expected that the nuclear rocket will precede electric propulsion in space travel. (A.G.W.)

37324 MANIPULATING DEVICES HAVING MASTER AND SLAVE PORTIONS FOR THE REMOTE HANDLING OF OBJECTS. Patrick Hay Stephenson (to Pye Ltd.). British Patent 873,077. July 19, 1961. Filed Mar. 4, 1958.

A master-slave manipulator is patented, with which it is possible to operate into side or lateral positions and still be able to watch the manipulations through the viewing window. The manipulator consists of a horizontal tubular support with a master arm and a slave arm at opposite ends. The master arm is pivotally attached to a housing, which can rotate relative to the tubular support to allow lateral displacement of the slave arm out of the plane containing the tubular support and the master arm. The housing may be clamped to the tubular support after a desired lateral movement has been made. The slave arm is at least partially counterbalanced by a weight carried from the tubular support during lateral displacement of the slave arm relative to the master arm. (M.P.G.)

37325 IMPROVEMENTS RELATING TO GRAB DEVICES. John Ormerod Pounder and Eric Watson (to United Kingdom Atomic Energy Authority). British Patent 934,222. Aug. 14, 1963. Filed Jan. 5, 1961.

A remotely operable grab device with separate grasping means for fittings of different character is patented. The grasping means are maintained positively positioned throughout the operative range of travel of a movable actuating member, so that the functioning of one grasping means is not interfered with by another. Actuation to the engaged states of the grabs occurs in successive steps of movement of the actuating member, so that the separate grabs are selectively actuable by adjustment of the actuating member to different points in its operative range of

travel. The device is particularly applicable to a reactor charging facility. (M.P.G.)

37326 IMPROVEMENTS IN AND RELATING TO PRESSURE VESSELS. (to Babcock and Wilcox Co.). British Patent 934,327. Aug. 14, 1963. Priority date Apr. 24, 1961, United States.

A pressure vessel equipped with a nozzle welded to the wall and extending beyond both sides of the wall is patented. To reduce the temperature gradient and thermal stresses where the nozzle is welded to the pressure vessel, the nozzle contains an internal sleeve, which creates a stagnant fluid pocket between the internal sleeve and the interior of the nozzle. (M.P.G.)

37327 IMPROVEMENTS IN CONTAINMENT VESSELS. William Robert Wootton (to Babcock & Wilcox Ltd.). British Patent 936,012. Sept. 4, 1963. Filed Jan. 23, 1961.

A containment vessel of welded construction designed to withstand fluid pressure differences is patented. To avoid the necessity of stress-relieving after welding, a dome-shaped cover instead of a flat plate is used to close the large access port. The thickness of the cover and the thickness of the flange on the containment vessel in the regions where they are welded together are less than the thickness at which stress relieving would be required. The inner surfaces of the flange and cover form a hemisphere or part of an ellipsoid. (M.P.G.)

37328 IMPROVEMENTS IN OR RELATING TO MASS SPECTROMETER ION SOURCE ASSEMBLIES. John Leece (to United Kingdom Atomic Energy Authority). British Patent 937,244. Sept. 18, 1963. Filed Nov. 4, 1960.

A mass-spectrometer ion-source assembly, which is compact and easily accessible for maintenance, is patented. The ion source is supported by a tubular column mounted on a base plate. A sample inlet pipe extends through the column from the base plate to the ion source. Electrical connections pass through seals in the base plate and extend to the ion source outside of the column. The support column is longitudinally slotted over most of its length and is mounted on the base plate by means of an end flange. (M.P.G.)

Heat Transfer and Fluid Flow

Refer also to abstracts 38447, 38448, 38449, 38453, 38454, 38476, 38477, 38478, and 38479.

37329 (ANL-6710) TRANSIENT BEHAVIOR OF A NATURAL-CIRCULATION LOOP OPERATING NEAR THE THERMODYNAMIC CRITICAL POINT. Darrel G. Harden (Oklahoma State Univ., Stillwater; Argonne National Lab., Ill.; and Associated Midwest Universities, Lemont, Ill.). May 1963. Contract W-31-109-eng-38. 95p.

Analytical and experimental studies were made of the transients encountered when a natural-circulation loop is operated in the critical region. The analytical study consisted of simulating the loop by using a digital computer to predict the measured transients. The experimental study was made on a loop containing Freon-114, and the following observations were made: Sustained flow and pressure fluctuations occurred when the density-enthalpy product as a function of temperature, enthalpy, or density reached a maximum. The magnitude and frequency of the fluctuations depended on whether the maximum in the density-enthalpy curve was being traversed from the low- or high-temperature side. The different frequency modes are explained. (D.L.C.)

37330 (BNL-6672) A CORRELATION FOR BOILING HEAT TRANSFER TO SATURATED FLUIDS IN CONVECTIVE FLOW. John C. Chen (Brookhaven National Lab., Upton, N. Y.). Dec. 26, 1962. Contract [AT(30-2)-Gen-16]. 35p.

An additive mechanism of micro- and macro-convective heat transfer was formulated to represent boiling heat transfer with net vapor generation to saturated, non-metallic fluids in convective flow. The final equations are:

$$h_{mic} = 0.00122 \frac{K_L^{0.79} C_{pL}^{0.45} \rho_L^{0.49} \Delta T^{0.24} \Delta P^{0.75} g_c^{0.25}}{\sigma^{0.5} \mu_L^{0.29} \lambda^{0.24} \rho_v^{0.24}} \times S$$

$$h_{mac} = 0.023 \frac{Pr_L^{0.4} Re_L^{0.8} k_L}{D} \times F$$

$$h = h_{mic} + h_{mac}$$

The second equation will be recognized as the Dittus-Boelter equation with the additional factor F. The two functions F and S are defined as $F = (Re/Re_L)^{0.8}$ and $S = (\Delta T_e/\Delta t)^{0.99}$, where Re is the effective Reynolds number for the two-phase fluid and ΔT_e is the effective superheat for bubble growth. F and S were obtained as functions of the Martinelli parameter and the two-phase Reynolds number, respectively. The correlation was tested with available data for water and organic fluids. Data from different sources which could not be satisfactorily correlated by existing correlations were shown to be quite well correlated by the one presently proposed. The average deviation between calculated and measured boiling coefficients for all data points from nine experimental cases was ±11%. (auth)

37331 (EUR-377.d) BESTIMMUNG DER TEMPERATURLEITFAHIGKEIT IN EINEM HOHLZYLINDER MITTELS DER LOSUNG DER FOURIER'SCHEN DIFFERENTIALGLEICHUNG DER WARMELEITUNG. (Determination of Thermal Conductivity in a Hollow Cylinder by Solving the Fourier Differential Equation for the Thermal Conductivity). G. di Cola and R. F. Gloden (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. European Scientific Data Processing Center, Ispra, Italy). 1963. 53p.

The time required for the external surface temperature of a tube of material to reach half its maximum value after internal heating by an instantaneous heat impulse is determined. Through solution of an eigenvalue problem arising from application of the heat equation to an insulated hollow cylinder, the temperature is expressed as a series of Bessel functions. The temperature is plotted as a function of a variable τ, ~ conductivity × time. The conductivity is then calculated from the τ and the time corresponding to half the maximum temperature. (D.C.W.)

37332 (HW-77594) THE CRITICAL FLOW OF HOT WATER THROUGH SHORT TUBES. F. R. Zaloudek (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1963. Contract AT(45-1)-1350. 36p.

The flow-pressure differential characteristics of 14 different short tubes carrying initially heated and compressed water to a region of low pressure were investigated. These tubes were 0.03 to 5 in. in length and 0.25 to 0.625 in. in diameter; all had sharp leading edges. Two discreet choking phenomena were visually experimentally observed in the tubes. The first occurred near the vena contracta near the inlet of the tube when the local static pressure dropped to approximately the saturation pressure. During this choking phenomena, the pressures on both sides of the tube were considerably above the saturation pressure. When the downstream pressure was lowered below the saturation value, the choking ceased and an annular flow

pattern was set up that allowed the metastable passage of the water through the tube. At still lower back pressures, a second choking phenomenon occurred at the downstream end of the test section. The critical flow rate at which this downstream choking occurred was dependent principally on the upstream pressure and temperature. A slight systematic dependence of the critical flow rate on tube dimensions was suggested by the data, but it could not be separated quantitatively from the scatter of experimental points with any certainty. The experimental critical mass velocities for the downstream choking approximated the values predicted by both a surface tension model developed by Burnell, and Kinderman and Wales and a surface evaporation model proposed by Bailey. This correspondence between the present data and the predictions of greatly dissimilar models was attributed, in part, to the semiempirical nature of the predicting equations. Visual observations of the choking phenomenon in a glass test section revealed features indicative of both the flow models, and the simultaneous existence of both mechanisms was suggested. (auth)

37333 (KAPL-M-EC-30) TEDDR — THERMAL DESIGN DATA REDUCTION. Eugene F. Adiutori and Ann Tedesco (Knolls Atomic Power Lab., Schenectady, N. Y.). June 20, 1963. Contract W-31-109-eng-52. 72p.

The TEDDR program which reduces the thermal and hydraulic data obtained from "in-pile" subassemblies is described. The program determines the following: heat transfer coefficients on fuel plate surfaces as a function of core life; heat transfer fouling coefficients on fuel plate surfaces as a function of core life; and fuel thermal conductivity as a function of core life. Computational equations, listings, and sample input and output are included. (auth)

37334 (LA-2910) A METHOD FOR COMPUTING NONSTEADY, INCOMPRESSIBLE, VISCOUS FLUID FLOWS. Jacob E. Fromm (Los Alamos Scientific Lab., N. Mex.). May 1963. Contract W-7405-eng-36. 152p.

A description is given of a method for obtaining numerical solutions to nonsteady incompressible fluid flow problems. Included are discussions of stability properties of the finite difference equations, and boundary and initial conditions appropriate to current applications of the numerical program. Solutions are given for flows about obstacles in a channel at various Reynolds numbers, with emphasis given to the process of development of the Karman vortex street. (auth)

37335 (ORNL-TM-618) NOTES ON THE LIQUID-METAL BOILING PHENOMENON. A. I. Krakoviak (Oak Ridge National Lab., Tenn.). July 10, 1963. Contract [W-7405-eng-26]. 33p.

A brief review of boiling for ordinary fluids with emphasis on the wall superheat required for bubble initation from different surfaces at varying pressures is presented. Calculations based on an equation valid for normal fluids indicate that superheats from two to eight times that for water are required to initiate a vapor bubble in some of the alkali metals. The high superheat and the high thermal conductivity peculiar to liquid metals are combined to explain the unstable liquid-metal boiling phenomenon in natural- and forced-circulation loops. Forced-convection boiling-potassium heat-transfer coefficients correlated by the Lockhart-Martinelli two-phase flow parameter are in reasonable agreement with the forced-convection boiling-water data of Dengler and Addoms. Some recommendations on bubble initiation sites and future work with liquid metals are also included. (auth)

37336 (TID-19371) LOW HEAT-FLUX BOILING (thesis). Quarterly Progress Reports No. 6, 7, and 8, October 1, 1962–July 1, 1963. John A. Clark, Edward R. Lady, Herman Merte, Jr., and William C. Elrod (Michigan. Univ., Ann Arbor. Coll. of Engineering). Aug. 1963. Contract AT(38-1)-260. 128p. (ORA-04653-5-P)

This investigation presents experimental data from tests of boiling saturated distilled water from the outer surface of a horizontal tube at low values of heat flux, 5,000 to 100,000 Btu/hr-ft^2, and elevated pressures, 535 to 1550 psia. Both natural convection (pool boiling) and water velocities up to 4.7 ft/sec normal to the axis of the tube are studied. The design of a system to carry out the boiling studies at pressures up to 2000 psia and temperatures up to 635°F is discussed in detail. The results are presented in a series of figures which show the heat flux as a function of wall superheat, $(T_w - T_{sat})$, for pressures of 535, 1015, and 1550 psia and velocities of 1.3 and 4.7 ft/sec, as well as pool boiling. A pronounced hysteresis effect is noted, with a higher wall superheat required at a given flux for increasing heat flux. The curve for decreasing heat flux is more stable and reproducible. An empirical equation which fits the pool boiling data in the range of 535 to 1550 psia, for the decreasing heat flux condition, is $(q/A) = 13{,}700\ (p^*)^{1.72}\ (T_w - T_{sat})^{f(p^*)}$, where $f(p^*) = 1.56\ (p^*)^{-1/5}$ and (q/A) is heat flux, Btu/hr-ft^2, p^* is the reduced pressure, p/p_{crit}, and $T_w - T_{sat}$) is the wall superheat, °F. The effect of a velocity normal to the tube is to reduce the wall superheat at a given heat flux. It is concluded that the heat flux in nucleate boiling of water is proportional to the wall superheat raised to a power between 1.7 and 2.1. The effect of increasing the system pressure in the range studied is to decrease the wall superheat at a given flux. The effect of heat flux history is significant for tests of up to several hours. The temperature difference appears to approach an asymptotic value for prolonged boiling at constant heat flux, regardless of the prior heat flux from the surface. (auth)

37337 (UJV-666/62) VLIV ELEKTRICKÉHO POLE NA PŘESTUP TEPLA DO PROUDÍCÍHO CO_2 A VZDUCHU V JADERNEM REAKTORU. (Effects of Electric Field on the Heat Transfer from Fuel Element to CO_2 Coolant). Frant Berger and Lad Derian (Československá Akademie Ved. Ustav Jaderneho Vyzkumu, Řež). [1962]. 42p.

The results of experiments in which the effect of electric fields on the heat transfer from a fuel element in partially ionized streaming cooling gas in a reactor was studied are given. The experiments were carried out in a reactor loop. CO_2 and air at pressures from 1 to 2 atm were used. An increase of the heat transfer coefficient by 40% was attained in the experiments using electric field. The results are expressed in function of the modified Richardson criterion and of the gas pressure. (auth)

37338 HEAT TRANSFER IN NUCLEAR INSTALLATIONS. M. Bogaardt. Ingenieur (Utrecht), 75: No. 35, W123-6(1963). [(In Dutch)]

The importance of high specific power and high heat flux is explained, and the measures to be taken to obtain high specific power are indicated. As examples of heat exchange equipment in the external reactor circuit, the primary heat exchangers, the pressurizer and several other items are mentioned. A few other reactor types are briefly considered as far as their thermodynamic characteristics are concerned. (auth)

37339 THERMAL ASPECTS OF NUCLEAR POWER STATIONS. D. G. H. Latzko. Ingenieur (Utrecht), 75: No. 35, W126-36(1963). [(In Dutch)]

A comparison between the economics and the technical principles of fossil and nuclear power generation systems shows one of the main design goals of the latter to be: maximum heat extraction from the reactor core combined with maximum conversion efficiency of this heat to mechanical power. By dividing the heat transfer process into three distinct phases, viz. within the fuel element, from fuel element to coolant and from coolant to steam cycle, the inherent limitations and sometimes conflicting requirements for achieving the aforementioned goal are brought out and discussed for various reactor coolants. (auth)

37340 HEAT TRANSFER: A REVIEW OF CURRENT LITERATURE. E. R. G. Eckert, E. M. Sparrow, W. E. Ibele, and R. J. Goldstein (Univ. of Minnesota, Minneapolis). Intern. J. Heat Mass Transfer, 6: 761-91(Sept. 1963). (In English)

Experimental and theoretical research on numerous aspects of heat transfer is reviewed. A variety of heat transfer systems, materials, and applications are considered. 628 references. (D.C.W.)

37341 TURBULENT HEAT TRANSFER IN A TUBE WITH CIRCUMFERENTIALLY-VARYING TEMPERATURE OR HEAT FLUX. E. M. Sparrow and S. H. Lin (Univ. of Minnesota, Minneapolis). Intern. J. Heat Mass Transfer, 6: 866-7(Sept. 1963). (In English)

An analysis of turbulent heat transfer in a tube with a circumferentially-varying temperature or heat flux is presented. (auth)

37342 HEAT TRANSFER TO BOILING HELIUM. M. D. Reeber (IBM Corp., Yorktown Heights, N. Y.). J. Appl. Phys., 34: 481-3(Mar. 1963).

The coefficient of heat transfer betweeen a smooth vertical silver surface and liquid helium is typically 0.020 ± 0.005 W cm^{-2} $°K^{-1}$ for convection and increases in the pool boiling range to 0.22 W cm^{-2} $°K^{-1}$ for 0.040°K superheat at 4.0°K. The heat transfer rate for pool boiling decreases with decreasing temperature between 4.0 and 2.5°K in proportion to the latent heat of vaporization and inversely as the molar volume of the vapor at the pressure and temperature of the experiment. The superheat in the steady state is determined by the volume rate of gas production at the surface. The hysteretic nature of the heat transfer curves in the boiling range suggests a nucleation mechanism strongly dependent on the thermal history of the specimen. (auth)

37343 BOILING NEAR THE CRITICAL FLUX ON HORIZONTAL PLATES. David Bruce Kirby. Thesis, Urbana, Ill., Univ. of Illinois, 1963. 134p.

An investigation was made of liquid-vapor interactions in a boiling liquid very close to the heated surface. Carbon tetrachloride and methanol were boiled on a heated, two-inch square, ground-glass surface. The boiling surface was coated with a transparent, electrically conducting material, which was heated by direct current. The boiling liquid was photographed through the glass from below. The vapor-liquid interactions could be viewed close to the surface, even at the maximum heat flux, for which the vapor production becomes very great. All tests were at atmospheric pressure, with no subcooling and no forced convection. Heat flux versus temperature-drop curves were recorded to Q/A = 90,300 Btu/hr · ft^2 for CCl_4 and to 142,000 Btu/hr · ft^2 for CH_3OH. The average maximum flux for CCl_4 was 81,000 Btu/hr · ft^2. Type I bubbles were defined as those growing without interference from surrounding vapor, type II as those growing with interference, and type III as those bubbles growing under large coalescences. Type I bubbles predominated at low fluxes and were the type of bubbles that previously were thought to be typical. At high fluxes, type II and III bubbles predominated. For CCl_4, the maximum bubble diameter varied from 0.0171 in. at 9,800 Btu/hr · ft^2 to 0.00944 in. at 90,300 Btu/hr · ft^2. The bubble cycle periods were in a range between 0.00323 and 0.00173 second, with a minimum at medium fluxes. Site densities ranged from 330 to 4,050 sites/in^2. The entire latent heat flow carried by single bubbles was estimated to average about 9% of the total flux between 9,800 and 90,300 Btu/hr · ft^2. (Dissertation Abstr.)

37344 A LOOK AT THE THERMODYNAMIC CHARACTERISTICS OF BRAYTON CYCLES FOR SPACE POWER. Arthur J. Glassman and Warner I. Stewart (Lewis Research Center, Cleveland). New York, American Inst. of Aeronautics and Astronautics, 1963, Preprint 63-218, 13p, $1.00. (CONF-97-23)

From Summer Meeting, Los Angeles, June 1963.

An analysis of the thermodynamic characteristics of Brayton cycles was undertaken in order to determine cycle efficiency and to select a desirable set of cycle temperatures. Minimum prime radiator area was selected as the criterion for cycle temperature selection. The effects of such design factors as turbine and compressor efficiencies, loss pressure ratio, and recuperator effectiveness on cycle efficiency are shown. The effects on radiator area of these factors and additional factors of turbine inlet temperature, sink temperature, radiating surface emissivity, and gas heat transfer coefficient are shown. It was concluded that required radiator area can be reduced by increasing turbine inlet temperature, turbomachinery efficiency, loss pressure ratio, recuperator effectiveness, gas heat transfer coefficient, and surface emissivity and decreasing sink temperature. The optimum values of turbine exit to inlet temperature ratio and compressor inlet to turbine inlet temperature ratio were found to be generally in the range 0.70 to 0.80 and 0.25 to 0.35, respectively. (A.G.W.)

37345 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGE APPARATUS. Andre Huet. British Patent 934,409. Aug. 21, 1963. Priority date Jan. 2, 1959, France.

A heat exchanger or vapor generator particularly suited to a steam-generating plant is patented. The heat exchanger consists of a vertical shell with an inlet and outlet at the ends and a plurality of tubes inside. The tubes are arranged in groups, one above the other, and each group contains a plurality of helically coiled tubes. The tubes of all the groups are connected in parallel to a common inlet. The tubes have diametrically extending fins inwardly or outwardly inclined with respect to the length of the helix. Deflecting surfaces are provided within the innermost helix of each group and between adjacent tube groups. Pressurized hot water, steam, or a mixture is passed through the tube groups, while water to be evaporated passes through the shell from bottom to top outside the tubes. The fins and deflecting surfaces cause the water outside the tubes to be forced outward and the steam to collect in the central region. (M.P.G.)

Materials Testing

37346 (ANL-6680) A REVIEW OF ULTRASONIC IMAGING METHODS, WITH A SELECTED, ANNOTATED BIBLIOGRAPHY. Harold Berger and R. E. Dickens (Argonne National Lab., Ill.). July 1963. Contract W-31-109-eng-38. 32p.

This review includes a discussion of many methods for detecting ultrasonic images with emphasis upon the prob-

lems involved in a nondestructive inspection system employing ultrasonic imaging techniques. The detection methods are compared from the standpoint of threshold sensitivity. It is concluded that a system which will respond to an ultrasonic intensity of 10^{-3} w/cm^2 or less will probably be necessary for a practical nondestructive inspection system. The detection methods which meet this requirement include those classified as optical and mechanical, and as electronic. The annotated bibliography includes 74 entries, many of which contain more than one reference. Included in this bibliography are references to most of the known methods for ultrasonic imaging. (auth)

37347 (ANL-FGF-394) THEORY AND SOME APPLICATIONS OF PULSED CURRENT FIELDS TO THE PROBLEMS OF NONDESTRUCTIVE TESTING. C. J. Renken (Argonne National Lab., Ill.). Sept. 19, 1962. Contract [W-31-109-eng-38]. 39p. (UAC-6946)

A treatment is presented of the behavior of pulsed-current fields in a dispersive medium with reference to use of pulsed eddy currents in nondestructive testing. The concept of phase, group, and signal velocities is discussed. The case of a plane wave impinging on a good conductor is considered. Two pulsed eddy current field systems are reviewed in some detail: through-transmission system and double pulse eddy current test system. The reflection of time-varying electromagnetic fields from good conductors is considered. The advantages of pulsed fields over sinusoidal fields are described. (D.L.C.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

Refer also to abstracts 37013, 37014, and 37059.

37348 (AD-291150) PROJECT SAN ANDREAS AFTERSHOCK RECORDING. Final Report. W. H. Westphal (Stanford Research Inst., Menlo Park, Calif.). June 30, 1962. Contract AF49(638)-1071. 30p.

Aftershock sequences were measured from ten earthquakes between June 1960 and September 1961 with the objective of evaluating aftershock monitoring as an on-site inspection technique. To be of value for on-site inspection, aftershock monitoring must be able to distinguish between the aftershocks of an earthquake and those of an underground explosion. Particularly useful aftershocks for on-site inspection are believed at present to be those of sufficient magnitude to be detected at distances of 8 km or more (over a 200 km/sq area) from the source of the primary event, those from a magnitude 4 to 6 primary event, and those that occur at least four days after the primary event. (auth)

37349 (NSEC-98) METEOROLOGICAL ASPECTS OF RADIONUCLIDE DEPOSITION BY PRECIPITATION. L. G. Davis and R. C. Koch (Nuclear Science and Engineering Corp., Pittsburgh). July 1963. Contract AT(30-1)-3072. 58p.

A review is presented of data for various scales of the spatial and temporal variations in the deposition of nuclear debris at ground level. A statistical analysis of concentrations between selected meteorological parameters and the Sr^{90} content of individual precipitations which occurred during the moratorium period accounted for over 73% of the total variance of Sr^{90} concentration in winter precipitations and for approximately 50% of the variance in summer precipitations. Approximately 60% of the variance was explained for Sr^{90} deposition for each of these seasons. These results indicate that some use can be made of these routinely available meteorological parameters to estimate values of Sr^{90} concentration and deposition in individual precipitations. (auth)

37350 (SC-4693(RR)) SEISMIC DATA FROM HIGH EXPLOSIVE CRATERING TESTS AT NEVADA TEST SITE. APPENDIX A. SPECTRA OF SEISMIC SIGNALS. APPENDIX B. SEISMOGRAMS. Dorris M. Hankins (Sandia Corp., Albuquerque, N. Mex.). Apr. 1963. Includes APPENDIX C. INSTRUMENTATION. Gordon J. Hansen. Contract [AT(29-1)-789]. 76p.

Three components of short-period seismic signals from several chemical explosive cratering tests at Nevada Test Site (NTS) were recorded on seismometers at four stations with epicentral distances of 165 ± 25 km. Travel time data are given for first and second P arrivals and S or Lg arrivals. Seismic signals were found to vary significantly with azimuth, presumably because of differences in geology. Effects of variation in yield, depth of burst, and medium on seismic signals are discussed; however, all are influenced by the azimuthal effect. The magnitudes of seismic signals from explosions at similar depth conditions are found to vary as the $\frac{2}{3}$-power of the yield. Amplitudes of seismic signals increase as depth of burst of cratering shots increases. Relatively smaller teleseisms are produced by explosions in alluvium than by those in basalt. Tukey Spectrum Estimation computer program was used to determine the frequency content of the signals and its variation with parameters involved, and to compute relative energies for different seismic phases and different shots. (auth)

37351 (SCR-679) FREE-FIELD GROUND MOTION PRODUCED BY EXPLOSIONS. William R. Perret (Sandia Corp., Albuquerque, N. Mex.). July 1963. Contract [AT(29-1)-789]. 34p. (CONF-197-1)

From Symposium on Scientific Problems of Shelter Construction, Zurich, July-Aug. 1963.

The reactions of rocks and soils to large explosions are discussed. Several experiments planned to measure ground motion produced by chemical and nuclear explosions in soil and in rock are described. The discussions are confined chiefly to those portions of the force field, which are most likely to be of concern to shelter design and construction. Both underground and low-altitude above-surface explosions were considered. (M.G.C.)

37352 GRAIN SIZE DISTRIBUTION AND FREQUENCY OF LONG-LIVED RADIOACTIVE AEROSOLS IN THE ATMOSPHERE NEAR THE EARTH. Martin Sedlacek, Othmar Preining, and Friedrich Ernst (Universität, Vienna). Acta Phys. Austriaca, 16: 296-303(1963). (In German)

The atmosphere near the earth was sampled with an aerosol spectrometer and the foils carrying the air dust were autoradiographed. A classification of the radioactive particles according to their activities into two groups was made using two autoradiographs with different contact times. From the distribution of the density sites on the autoradiographs, the grain size spectrum of both particle groups can be determined. The time variation of the grain size distribution since the inception of the research was given. Samples were obtained from the aerosol spectrometer foils and their long-lived β activity was determined in an anticoincidence apparatus. The grain size distribution of the total activity was estimated. (tr-auth)

37353 THE SIGNIFICANCE OF RADIATION EXTINCTION IN GLACIER ICE FOR ENERGY EXCHANGE STUDIES. W. Ambach (Universität, Innsbruck, Austria). Acta Phys. Austriaca, 16: 382-4(1963). (In German)

The ice surface of a glacier consists, generally, during the ablation time of a very porous ice layer (overlayer), which can vary sharply in thickness and structure. The radiation extinction measurement is a function of the porosity of the overlayer. The radiation balance was measured for depths of 0 to 50 cm and the density of the overlayer was calculated. The theory of Dunkle and Gier was applied to the ice under the overlayer. The scattering coefficient is independent of wave length, and the ratio of underlight to overlight varies sharply with the extinction coefficient. (J.S.R.)

37354 MATHEMATICAL DEVELOPMENT OF DISCRETE FILTERS FOR THE DETECTION OF NUCLEAR EXPLOSIONS. Enders A. Robinson (University Inst. of Statistics, Uppsala). J. Geophys. Res., 68: 5559-67 (Oct. 1, 1963).

The mathematical theory of the following discrete filters to be used on digitized data from microbarographic and seismic records for the detection of nuclear explosions is developed: matched filter, modified matched filter, modified matched filter for a multiparameter model, filter for the estimation of the trend component, wave-shaping filter, wave-shaping filter in the noiseless case, and spike

filter. Finally a simplified computational method is given for the case of stationary noise. (auth)

37355 AGE MEASUREMENTS OF ANTARCTIC ROCKS (QUEEN MAUD LAND). P. Pasteels and Sarah Deutsch (Université Libre, Brussels). Nature, 199: 996-7(Sept. 7, 1963).

Age measurements of various eruptive and metamorphic rocks from the Sör-Rondane Mountains of Queen Maud Land, based on isotopic measurements, ranged from 460 to 500 million years. (C.H.)

37356 RADIO ISOTOPES—GEOLOGY: SOME CONTRIBUTIONS TO THE KNOWLEDGE OF THE ORIGINATION AND DEVELOPMENT OF SOLAR SYSTEM AND EARTH. H. N. A. Priem. Ned. Tijdschr. Natuurk., 29: No. 6, 185-208(1963). [(In Dutch)]

A review study was made of the following subjects: radioactive nuclides with short and long half lives; radiometric age estimation; radiometric ages of terrestrial rocks and minerals; radioisotopes-geochemistry of lead; radiometric and lead-model ages of meteorites; time interval between the end of the nucleus synthesis, and the formation of planets and planetoides; constancy of the intensity of the cosmic radiation; and the irradiation ages of meteorites. (RCN)

37357 QUANTITATIVE DETERMINATION OF BED PARAMETERS FROM GAMMA-RAY LOGS. Jan A. Czubek (Inst. of Nuclear Research, Polish Academy of Sciences, Krakow). Nukleonika, 8: 177-84(1963). (In English)

Quantitative interpretation of gamma-ray logs performed inside the boreholes by means of continuous measurement is described. The method presented affords interpretation in the case of different measurement parameters as v – the logging speed, τ – the time constant of ratemeter, and other geological and formation parameters that occur in the geophysical practice. (auth)

37358 SOME OBSERVATION DEALING WITH ARTIFICIAL RADIOACTIVITY OF EXTERNAL ENVIRONMENT. J. Matoušek, F. Mertl, and S. Patočka (Karlova Universita, Pilsen, Czechoslovakia). Plzensky Lekarsk. Sb., 18: 57-63 (1962). (In Czech)

Several new methods for detecting radioactivity of external environment were used at the Physical Institute of Medical Faculty in Pilsen during the year 1961. The dependence of air radioactivity and fallout on the rains was observed. Catching effectiveness of the chromatographic papers Whatman 4 and membrane ultrafilters was compared and losses due to the burning of the chromatographic papers were evaluated. The method of gummed papers for orientation reasons was also used. (auth)

37359 SOME DATA FROM THE MEASUREMENT OF ARTIFICIAL RADIOACTIVITY OF EXTERNAL ENVIRONMENT. [PART II]. J. Matoušek, F. Mertl, and S. Patočka (Karlova Universita, Pilsen, Czechoslovakia). Plzensky Lekarsk. Sb., 19: 43-53(1962). (In Czech)

Some experiences with the introduction of new methods of dosimetry and detection of artificial radioactivity of external environment are reported. The capturing effect of filters from Whatman's chromatographic paper no. 4 is compared with membranous ultrafilters for radioactive aerosols. The dependence of radioactivity of the fallout on the presence of dust is followed, decay curves of samples of radioactive aerosols and rain with high initial specific activity are discussed and the change of form of absorption curves is followed in the dependence on the age of the sample. Autoradiograms of particles of radioactive fallout are presented. (auth)

37360 THE ESCAPE OF HELIUM FROM THE EARTH'S ATMOSPHERE. Gordon F. J. MacDonald (Univ. of California, Los Angeles). Rev. Geophys., 1: 305-49(Aug. 1963).

A review of upper atmospheric data and models, influx of gases into the atmosphere, and their thermal escape indicates that either some nonthermal mechanism presently permits a greater rate of He escape or that the escape rate has varied in time. Particularly, it is noted that some heat source other than solar ultraviolet radiation seems necessary to account for certain upper atmospheric density variations. Also, if this additional heat source is due to the solar plasma, historical fluctuations of the earth's magnetic field could seemingly result in a greater He escape rate. Long-period, large variations of the ultraviolet part of the solar spectrum could also account for the He loss. (D.C.W.)

37361 QUARTERLY REPORT (TWO QUARTERS) OF FUNDAMENTAL RESEARCH NO. 6111, FROM JULY 1, 1962 THROUGH DECEMBER 31, 1962. Alvin J. Cohen (Mellon Inst., Pittsburgh). 5p. (CONF-168-1)

From 21st Annual Meeting of the Electron Microscope Society of America, Denver, Aug. 1963.

Progress on fundamental geochemical research on tektites, stony meteorites, and radiation damage in related silicate materials is reported. Crater distribution on dimensions of the crater field are being studied in the Argentine meteorite craters. A systematic study of achondrites was initiated on a portion of Cumberland Falls, which fell at noon, April 9, 1919, in Whitley County, Kentucky. (M.C.G.)

HEALTH AND SAFETY

Refer also to abstracts 37008, 37026, 37055, 37056, 37112, 37113, 37121, 37352, 37364, and 38445.

37362 (AD-286933) ATTITUDES AND KNOWLEDGE CONCERNING FALLOUT SHELTERS IN AUSTIN, TEXAS. Harry Estill Moore (Texas. Univ., Austin). Jan. 1962. Contract CDM-SR-62-2. 139p.

A comparison of the knowledge of and attitudes toward home fallout shelters and related topics was made in Austin, Texas, during the Autumn of 1961. The study falls into three parts: the extent of knowledge possessed by citizens of Austin regarding fallout shelters and similar aspects of potential danger from open warfare; their attitudes toward such shelters, the Civil Defense organization, and the probability of nuclear attack in case of war; and the comparison of the two panels of informants in terms of these two factors. (P.C.H.)

37363 (CDRP-182-106) THE APPLICATION OF THE EQUIVALENT RESIDUAL DOSE CONCEPT TO OPERATIONAL PLANNING TECHNIQUES. Myron B. Hawkins (California. Univ., Berkeley. Inst. of Engineering Research). Oct. 10, 1962. Contract CD-SR-58-40. 60p. (AD-291448)

The equivalent residual dose concept proposed by the National Committee on Radiation Protection permits a more reliable prediction of the medical effects of nuclear radiation exposure during emergency conditions. The study investigates the use of this dose concept during the complex operational situations in the postattack period of a nuclear war. Preliminary planning aids have been developed to permit prediction of the maximum equivalent residual dose encountered in operational regimens involving three phases of radiation protection. Other parameters that can be varied are stay-times in each phase, the permissible dose, and the fallout radiation intensity level. The basic computer program can incorporate a much wider variety of parameters including daily changes in equivalent protection factor, variation in first day radiation exposure, decay rate, etc. Planning aids have been applied to a partial evaluation of standard fallout shelter specifications and the requirements for secondary shelter. The latter study indicates that the use of secondary shelters having a protection factor of about 10 and which could serve as temporary living and working areas would permit significant reductions in primary shelter stay-times. (auth)

37364 (HW-SA-3144) NATURAL REMOVAL PROCESSES IN THE ATMOSPHERE. J. J. Fuquay (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Aug. 5, 1963]. Contract AT(45-1)-1350. 16p. (CONF-198-1)

From United States Public Health Service Training School on Meteorological Aspects of Air Pollution, Berkeley, Calif., Aug. 1963.

A treatment is presented of the physics of the various processes of pollutant removal from the atmosphere: gravitational settling; diffusion to the surface; impaction; and removal by rainfall (rainout and washout). Meethan's calculations of the various balances (heat, water, smoke, and sulfur) involved in the disastrous London smog of Dec. 5 to 9, 1952, are considered in some detail. (D.L.C.)

37365 (NP-13078) TOTAL FALLOUT β-ACTIVITY OF PRECIPITATION AND AIR IN SWEDEN, JANUARY–JUNE 1963. G. Lindblom (Sweden. Forsvarets Forskningsanstalt, Stockholm). Aug. 1963. 8p.

Monthly radioactive deposition and monthly averages of activity in the air at ground level in Sweden are reported for the period Jan.–June 1963. Values from earlier years are given for comparison. (auth)

37366 (JPRS-20872) CONCERNING THE PROBLEM OF THE COMBINED EFFECT OF A HIGH-FREQUENCY ELECTROMAGNETIC FIELD AND X-RAY IRRADIATION UNDER INDUSTRIAL CONDITIONS. Yu. A. Osipov, R. N. Vol'fovskaya, T. P. Asanova, E. (Ye.) L. Kulikovskya, T. V. Kalyada, and A. V. Shcheglova. Translated from Gigiena i Sanit., 28: No. 6, 35-8(June 1963). 7p. (OTS-63-31658)

A syndrome in electronic tube testers, attributed to the combined effects of a high-frequency electromagnetic field and low-level x radiation, is described. The syndrome began to disappear with the complete or partial removal of one of the contributing factors. Case histories are included. (C.H.)

37367 MEASUREMENT OF TOTAL β-ACTIVITY IN THE ATMOSPHERE. F. De Francesco and M. Ghirardoni. Boll. Lab. Chim. Provinciali (Bologna), 13: 456-65(1962).

β-activity in the air in laboratories concerned with food control was measured with a scaler and a Geiger tube having a plateau of about 300 v in the curve relating counts per min. and applied voltage for a fixed radiation source. The sample of air (8 to 10 cubic meters) is aspirated through a filter-paper, 20 mm in dia, during 6 to 7 hr. The paper is then placed at a fixed distance under the window of the Geiger tube, and the count is recorded for 1 min. The counter is calibrated with finely powdered pure KCl, 1 g of which contains 40K equiv to 900 disintegrations per min. A known weight of the KCl is uniformly distributed on a similar filter-paper by suction from a sieve, and fixed with a few drops of Formvar in 1,2-dichloroethane, then counted. Details of calculations are given, and two monthly records are shown. (TCO)

37368 ROUTINE DOSE RECORDING IN DIAGNOSTIC RADIOLOGY. G. M. Ardran and H. E. Crooks (Health Physics and Medical Div., Harwell, Berks, Eng. and Oxford Univ.). Brit. J. Radiol., 36: 689-94(Sept. 1963).

Methods of measuring and ways of expressing patient dose in routine diagnostic radiography are briefly reviewed. Measurement of dose in units such as ergs or joules should be confined to instances when dose is measured in a specific structure: this will be a laboratory procedure since to obtain the data necessary may require several exposures. Routine dose measurement normally relies on a single measurement using an incident exposure meter which will include radiation not actually absorbed in the patient and which will record the same dose whether there is a patient in the beam or not. Dose measured in this manner should be recorded in $r \times cm^2$ in order that the results may not be considered to be more accurate than they really are. Results are given of a test of a commercially available $r \times cm^2$ instrument: and data are given which can be used to convert exposure into g-r assuming that all the radiation is absorbed in soft tissue, for kVp's between 50 and 150. In practice the ability to automatically integrate the area is usually more important than to correct for HVT. Dose meters of the $r \times cm^2$ type are useful in

fluoroscopy when the area is continually variable and for procedures in which the dose may be relatively high or when it is desired to keep a check on personnel in training. (auth)

37369 RADIOACTIVE CONTAMINATION IN THE FOOD CHAIN. J. P. G. M. Smeets. Euratom Bull., No. 3, 10-15 (1963). (In English)

The manner in which radionuclides find their way into foods and the extent to which the process occurs are reviewed. Qualitative and quantitative selection processes to which radionuclides are subjected significantly alter the concentration in which they enter the food chain; many will not succeed in passing the food chain at all. In view of effective half-life strontium-90, cesium-137, and iodine-131 are by far the most dangerous of the fission products. Factors that govern the extent to which radionuclides will actually appear on the table are identified as: physical and chemical properties of the radionuclides, environmental factors, biological factors, and factors connected with stock-piling, industrial processing, and domestic preparation. Aspects of direct and indirect contamination are discussed, and cases of naturally-occurring high activity food sources are presented. The role of Euratom in the fields of health physics and radiation safety is identified. (H.M.G.)

37370 THE DOSIMETRIC ASPECTS OF NUCLEAR ACCIDENTS. H. Van Ammers. Ingenieur (Utrecht), 75: No. 20, G1-13(1963); No. 22, G17-23(1963). [(In Dutch)]

In determining the radiation doses of exposed people many problems are still to be solved, as to: neutron dosimetry in connection with the relation between rad and rem dose; neutron spectrometry; neutron dose distributions in a human body or phantom; dependence on the incident neutron-energy-spectrum; and the problem of determining the separate gamma- and neutron-dose contribution in mixed neutron/gamma fields. (auth)

37371 CHEMICAL AND RADIOCHEMICAL COMPOSITION OF THE RONGELAPESE DIET. Diptiman Chakravarti (Univ. of Washington, Seattle) and Edward E. Held. J. Food Sci., 28: 221-8(Mar.–Apr. 1963).

The gross chemical composition of the Rongelapese diet indicates that it is low in fat, protein, and ash but fairly high in carbohydrate. The variation in gross chemical composition of the diets examined may be accounted for by the broad variability of the different diets. The habitat of the Rongelapese probably does not demand a high-energy diet, which may partially justify the lower fat intake. Levels of calcium and phosphorus seem below the minimum required for maintenance of a proper calcium-phosphorus balance. The diet seems adequate in magnesium and potassium but slightly low in sodium. The nickel, cobalt, and copper contents seem high in the Rongelap rations, manganese content is low, and iron and zinc compare favorably with minimum daily requirements. High levels of Co^{60} and Zn^{65} are associated with each other and with rations containing local fish. The higher levels of Sr^{90} and Cs^{137} are found where local fruit was consumed. Coconut contributes little Sn^{90}, and pandanus the most. Rations with higher Zn^{65} also contain higher levels of stable zinc, indicating that local sea foods may be the main source of zinc in the diet. Cs^{137}, Sr^{90}, and Co^{60} show no definite correlation with stable potassium, calcium, and cobalt, respectively. There is probably a net addition of minerals to Rongelap soils from imported foods. (Public Health Eng. Abstr., vol. 43: Sept. 1963)

37372 ENVIRONMENTAL RADIOACTIVITY IN BANDUNG AREA. Suwarno Wirjosimin. Madjalah Inst. Tekn. Bandung Proc., 1: No. 2, 52-64(1961). (In English)

Effects of the TRIGA Mark II reactor on the radiation environment of Bandung, Indonesia were studied. Samples of air, soil, water, and vegetation were collected and counted in an effort to establish a base line level of radioactivity prior to reactor operation. Lack of a low level counting room and adequate manpower thwarted attempts at achieving higher accuracy in background counting. Due to an insufficient number of counting series, a base line could not be drawn. Results, however, indicate that background activity values obtained are comparable and of the same order as those from atomic energy establishments abroad. (H.M.G.)

37373 HEALTH PHYSICS ASPECTS OF COMMISSIONING AND OPERATING NATURAL URANIUM GAS COOLED GRAPHITE MODERATED POWER REACTORS. D. J. Mathias. Nucl. Energy, 216-20(Aug. 1963).

Aspects of health physics to be considered in commissioning and operating British natural uranium gas-cooled graphite-moderated power reactors discussed are: permissible levels of external radiation to which personnel will be exposed, design philosophy, commissioning procedures, problems concerned with raising the plant to power and power operation, decontamination procedures, and instrumentation and dosimetry. (H.M.G.)

37374 X-RAY DOSE AND ENERGY DETERMINATION BY PERSONAL FILM MONITORING. Tadeusz Musialowicz and Juliusz Wysopolski. Nukleonika, 8: 191-201 (1963). (In German)

The basis of the method of personal monitoring by film badges in West Germany, the changed method of radiation hardness factor (correction factor) and radiation energy determination are presented. Application of the method worked out with some changes made possible the increase of dose and energy estimation precision. Relative error in dose estimation of x radiation up to 200 kv was in the range of ±30%. (P.C.H.)

37375 RADIATION DETECTION APPARATUS FOR PERSONNEL PROTECTION. J. Morichere. Onde Elec., 42: 858-66(Oct. 1962).

Details are included of an apparatus used for the protection of personnel against radiation. (TCO)

37376 THE GENETICALLY SIGNIFICANT RADIATION DOSE FROM LUMINOUS WRIST WATCHES. Renee McCarthy and V. Mejdahl (Danish Atomic Energy Commission, Risö, Denmark). Phys. Med. Biol., 8: 279-85(Sept. 1963).

Measurement of γ ray activity was made on 520 men's watches, 51 ladies' watches, 120 boys' watches, and 66 girls' watches and the respective average Ra contents obtained were: 0.059, 0.035, 0.031, and 0.017 μg. The frequency of persons wearing luminous wrist watches was estimated from a total of 1436 adults and children. The genetically significant dose to the Danish population was calculated and found to be approximately 1.2 ± 0.4% of that from the natural background. (auth)

37377 CONTAMINATION CONTROL OF PLUTONIUM-241 BY MEASUREMENT OF THE LOW ENERGY BETA RADIATION. H. J. Gale and L. H. J. Peaple (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Med. Biol., 8: 297-308(Sept. 1963). (AERE-R-4113)

Plutonium-241 (a β-emitter of maximum energy 20 kev) occurs with other Pu isotopes (α-emitters) in irradiated reactor fuel and in laboratories using material enriched in Pu^{241}, contamination control must be based on β-ray measurement. Direct monitoring of contaminated surfaces is impracticable, but smears from such surfaces, and samples of airborne dust collected on filter paper may be

measured either with an internal gas-flow proportional counter or a thin plastic scintillation phosphor. To detect the 20-kev β radiations, high amplification has to be used and accompanying α radiation then gives rise to several interfering effects which have been investigated. The gas-flow proportional counter cannot measure filter papers directly, and sample preparation is necessary; a concentration in air of about 0.2 of the maximum permissible value is detectable. To avoid the delay in ashing the scintillation system may be used, in which the limit of detection is about one maximum permissible concentration in air. Smear sampling of clean surfaces can enable contamination of about 0.2 of a maximum permissible level to be detected with the scintillation counter, and somewhat greater sensitivity with the less convenient proportional counter. (auth)

37378 RADIOACTIVE CONTAMINATION OF FOODS. PROBLEMS IN THE FOOD CONSUMPTION OF THE ITALIAN POPULATION. Anna Ferro-Luzzi and A. Mariani. Quaderni Nutr., 22: 1-28(1962).

37379 HEALTH PHYSICS. G. W. Dolphin, W. J. Megaw, and J. Rundo (Atomic Energy Authority, Harwell, Berks, Eng.). Rept. Progr. Phys., 25: 337-94(1962).

The aspects of health physics that are basically applications of physics are reviewed. Units of radiation measurement, RBE, permissible doses, personnel monitoring, applications of radiation spectrometry, and measurement of body activity are considered, as well as the release, dispersion, and deposition of radioactive material in reactor accidents. 140 references. (D.C.W.)

37380 RADIOACTIVITY AND RADIATION INJURIES. Pekka Vuorinen (Univ. Central Hospital, Turku, Finland). Sotilaslaaketieteellinen Aikakauslehti, 37: 115-33(1962). (In Finnish)

37381 MEDICAL ASPECTS OF MILITARY PLANNING. S. Urwitz. Svenska Lakartidn., 58: 3709-12(Dec. 14, 1961). (In Swedish)

Problems of handling large numbers of casualties from thermonuclear war are examined. (BBB)

37382 MILITARY PHYSICIANS AND ATOMIC MEDICINE. Bertil Aberg. Svenska Lakartidn., 58: 3730-1 (Dec. 14, 1961). (In Swedish)

37383 PHYSICIANS IN TOTAL DEFENSE. Stig Marcus. Svenska Lakartidn., 59: 1147-51(Apr. 12, 1962). (In Swedish)

The role of medical personnel in nuclear war is discussed. (BBB)

37384 CONTROL OF EXPOSURE TO RADIATION. Michel Des Saints (General Hospital, LaSalle, Verdun, Quebec, Canada). X-ray Technician, 34: 214-17(Jan. 1963).

The control of exposure to radiation is discussed with particular emphasis on medical exposures. The techniques involve the use of more sensitive film, the adaptation of the vision radiologist before making fluoroscopic examinations, and the use of shielding. (Public Health Eng. Abstr., vol. 43: Sept. 1963)

37385 INTRODUCTION TO AND DISCUSSION OF SAFETY REQUIREMENTS FOR IONIZING RADIATIONS. C. M. C. Brouerius Van Nidek. Ziekenhuiswezen, 34: 125-6(Apr. 1961). (In Dutch)

37386 LOCAL FALLOUT: HAZARD FROM NEVADA TESTS. CNI Testimony at a Congressional Hearing. Testimony before the Subcommittee on Research, Development and Radiation of the Joint Committee on Atomic Energy. Nucl. Inform., 5: No. 9, 1-12(Aug. 1963). St. Louis, Greater St. Louis Citizens' Committee for Nuclear Information, 1963. 12p. $0.50.

The analysis of the hazard from fallout in the region of the Nevada Test Site prepared by the St. Louis Committee for Nuclear Information is discussed. Analysis of the available evidence shows that children residing in the states bordering the Nevada Test Site have, as a result of fallout from nuclear tests at that site, probably been exposed to medically significant radiation. These exposures were avoidable, for on the basis of radiation monitoring carried out by the AEC during the test programs, the probability of exposure should have been evident in time to warn the population to take simple precautionary steps. Monitoring procedures in the Nevada Test Site regions have been inadequate in that they do not take into account the importance of internal exposure to radioactivity entering the body in fallout-contaminated food. Direct and prompt measurement of iodine-131 in local milk, which is the most effective method of estimating the hazard from this isotope was not done, or, if done, has not been reported. Moreover, indirect but nevertheless useful estimates of the iodine-131-hazard, which can be determined from the available gross gamma and beta radioactivity measurements were not made heretofore. Past assurances of the safety to nearby populations of the Nevada test programs are not substantiated by present analysis of available data. Assurances that the hazard is successfully confined to the controlled areas of the Test Site are not justified in the absence of direct measurements of radioactivity levels in local milk. Even the inadequate indirect measurements that have been carried out, if properly interpreted, should have alerted the responsible agencies to the serious potential health hazards during test programs and to the necessity of warning the population to take simple, readily available protective measures. These hazards are not restricted to atmospheric tests alone. Available data show that following at least seven underground tests, local fallout contamination comparable to that produced by atmospheric tests occurred. In view of the foregoing conclusions, a thorough review of present fallout monitoring procedures is recommended, with a view to rectifying the present inadequacies with respect to data, interpretation, and public information regarding precautionary measures. Due to the probable high radiation exposures to the population in the Nevada Test Site region a careful medical follow-up study of exposed individuals, in order to facilitate detection and treatment of possible diseases is suggested. (auth)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

37387 THE USE OF RADIOISOTOPES IN THE CHEMICAL AND PHARMACEUTICAL INDUSTRY. Hans Goette (Farbwerke Hoechst AG, Ger.). Euratom Bull., No. 3, 26-30(1963). (In English)

With the aim of highlighting the importance of radioisotopes in the present-day world of initiating discussion of the economic and technical problems entailed in their use, the Banque de Bruxelles organized a series of conferences in collaboration with the Euratom Eurisotop Bureau during March of this year. Radioisotopes, or artificial radioelements, are interesting because they are nothing more nor less than unstable atoms emitting either an electromagnetic radiation or a particle radiation, or both together. After the initial paper, which described the methods of producing isotopes, outlines were given of their applications in certain typical fields. The author demonstrated the usefulness of radioisotopes in the chemical and pharmaceutical industries. (auth)

37388 FOOD PRESERVATION BY RADIATION. ITS PRESENT STATUS . . . ITS FUTURE POTENTIAL. Samuel A. Goldblith (Massachusetts Inst. of Tech., Cambridge). Food Eng., 35: 49-52(May 1963).

Preliminary studies performed in the USA during the past decade have indicated that many foods, not readily canned or frozen, may be preserved or sterilized by radiation. The Food and Drug Administration has already (February 1963) issued its first regulation pertaining to food preserved by gamma radiation. Radiation required to retard sprouting of tubers, to inactivate microorganisms and insects, and to preserve vegetables, poultry, sea foods, and egg products is already charted. Only enzyme inactivation studies must be completed before radiation preservation of certain meats and meat products is to be considered practical. Radiation preservation promises to become very important in the future, as an aid to agriculture, and to make fresh foods available to areas where such supplies would otherwise price themselves out of the market. (TCO)

37389 THE TECHNICAL APPLICATION OF RADIOISOTOPES. J. H. Arlman. Ingenieur (Utrecht), 75: No. 34, 068-71(1963). [(In Dutch)]

The number of industries and applications does not increase yearly at a rate which might be expected according to the many favorable aspects of radioisotope use in industry. This is because of shortage of trained employees, lack of harmony of regulations and laws, inefficient administration and licensing procedures, exaggerated requirements for fire-safety in installations, insurance problems, and lack of published directions for waste disposal. A great number of examples for isotope applications are given which may illustrate the potency of this new tool for industry. (auth)

37390 USE OF RADIATION FOR STERILIZATION OR PRESERVATION IN FOOD AND PHARMACEUTICAL INDUSTRIES. Ramel Girard. Rev. Med. Moyen-Orient, 17: 461-96(Sept.-Oct. 1960). (In French)

37391 IMPROVEMENTS IN OR RELATING TO PACKAGE IRRADIATION SYSTEMS. William Henry Holland (to United Kingdom Atomic Energy Authority). British Patent 934,217. Aug. 14, 1963. Filed Sept. 26, 1960.

A package irradiation plant is patented. A conveyor passes packages through a biological shield surrounding a radioactive source. The packages are transferred by push rods onto trolleys suspended from rail-track circuits within the shield. The trolleys repeatedly convey columns of packages around the source. The packages are transferred by push rods from a trolley on one rail circuit to a different level on a trolley on another rail circuit and finally to a conveyor, which moves them out of the shield. At least one of the rail-track circuits is vertically movable by a jacking mechanism, so that the packages can be moved from one level to another. (M.P.G.)

37392 IMPROVEMENTS IN OR RELATING TO PACKAGE IRRADIATION SYSTEMS. Sidney Jefferson (to United Kingdom Atomic Energy Authority). British Patent 934,218. Aug. 14, 1963. Filed Dec. 30, 1960.

A package irradiation system for conveying packages past a radioactive source is patented. The packages are moved on trolleys, which can be moved vertically through an aperture in the biological shield surrounding the source. A moveable section of the railway, from which the trolleys are suspended, can be aligned with fixed portions of the railway inside and outside the shield. Each end of the lifting device, which moves the trolley and railway, forms a radiation shielding plug for the aperture in the shield. The upper plug closes the aperture when the lift is in its lowest position, and the lower plug closes the aperture when the lift is in its highest position. A collar of shielding material is located above and below the aperture to increase the effective shielding near the aperture. (M.P.G.)

37393 FIBERS. (to American Cyanamid Co.). British Patent 935,052. Aug. 28, 1963. Priority date United States, Apr. 20, 1961.

A thermally stable, preformed, dyeable polypropylene fiber of good tensile strength and methods for preparing it are patented. Preformed polypropylene fiber in the solid state is irradiated with β rays, electromagnetic radiation, or high-energy electron beams and chlorinated by exposure to Cl gas until the fiber contains a Cl content of from 5 to 15%. The fibers are then reacted with a polyamine at temperatures between 15 and 150°C, so that the polyamine reacts with at least 50% of the chloro groups in the fiber molecule. (M.P.G.)

INSTRUMENTS AND INSTRUMENTATION

General and Miscellaneous

Refer also to abstracts 37802 and 37803.

37394 (EUR-406.e) FAST LOW LEVEL PULSE HEIGHT DISCRIMINATOR. E. de Blust, V. Mandi (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy); and I. de Lotto (Centro Informazioni Studi Esperienze, Milan). 1963. 52p.

The behavior of the tunnel diode in a fast low-level pulse height discriminator is analyzed. The characteristics of the tunnel diode in fast trigger circuits are studied by plotting the switching waveforms for nonlinear load and variable input pulse amplitude and shape. The relations between the switching time, the "lambda" pulse, and the hysteresis are considered and extended also to the classical trigger circuits. As a result of the analysis a discriminator circuit was developed after an investigation of the different bias circuits. The lowest threshold level is about 2 mv and the input range is higher than 100. The linearity is satisfactory over the whole range and a good temperature stability can be achieved with a simple and cheap thermostat. The length of the "lambda" signal is about 8 nsec but could be further reduced with faster components and more care in the circuit lay-out. (auth)

37395 (LRP-2-63) UNE SONDE POUR HAUTE TENSION, EN CONNEXION AVEC UN CIRCUIT INTEGRATEUR TRANSISTORISE, A TRES LARGE BANDE. (A High-Voltage Probe, in Connection with a Transistorized Integrator Circuit, With Very Large Pass Band). R. Keller (Laboratorie de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Apr. 1963. 20p.

A high voltage probe based on the principle of consecutive differentiation and integration and offering a pass band with a very high cut off (100 Mc) is described along with a transistorized integrator having a very wide pass band (300 c to 300 Mc). (D.C.W.)

37396 (RT/EL(63)11) UN OSCILLOGRAFO RAPIDO A QUATTRO TRACCE INDIPENDENTI. (A Fast Response Oscilloscope with Four Independent Channels). A. Alberigi Quaranta and M. Radicchi (Bologna. Universita. Instituto di Fisica and Italy. Istituto Nazionale di Fisica Nucleare Bologna). June 1963. 16p.

An oscilloscope for pulses having a rise time of some nanoseconds is described. It has two independent time-base generators and a cathode-ray tube with four electron guns. The greatest sweep rate is 7.5 nsec/cm. The accelerating potential may be 10 or 20 kv, and the vertical deflection factor is 19 v/cm and 37 v/cm, respectively. Inside, there are four Hewlett & Packard amplifiers type 460B, which may be inserted in the circuit of Y plates. With the amplifiers the sensitivity is about four times as great. The oscilloscope is provided with an amplitude-calibrated pulse generator, a calibrator for the sweep units, and regulated power supplies. (auth)

37397 (RT/EL(63)12) SULLA REALIZZAZIONE DI AMPLIFICATORI LINEARI TRANSISTORIZZATI RAPIDI A GRANDE INTERVALLO DINAMICO DI FUNZIONAMENTO. (The Realization of Fast Transistorized Linear Amplifiers with a Large Dynamic Range of Operation). A. Alberigi Quaranta and M. Martini (Italy. Istituto Nazionale di Fisica Nucleare, Bologna and Bologna. Universita. Istituto di Fisica). June 1963. 20p.

The problem is discussed of building fast transistorized pulse amplifiers with a dynamic range of about 10v. A prototype circuit is presented exhibiting the following characteristics: voltage gain, 10; rise time, max 4.5 nsec., min 2.5 nsec; max output pulse, −12v; input and output on coaxial cable; good frequency overloading and good stability against room temperature variations. (auth)

37398 (TID-17848) THE ARGONNE 3-PARAMETER ANALYZER. Lowell M. Bollinger (Argonne National Lab., Ill.). Nov. 1962. Contract [W-31-109-eng-38]. 23p. (CONF-181-3; UAC-7048).

From Utilization of Multiparameter Analyzer Meeting, Grossingers, N. Y., Nov. 1962.

The general characteristics of the 3-parameter analyzer are described briefly. The experimental requirements which form a basis for the design of the analyzer are outlined. The operating experience (~10,000 hr of running time) and the performance of analyzer components are reviewed. A critical examination is made of the data storage and analyzing system. The features of the search station for selecting and recording only the required spectra are listed. (D.L.C.)

37399 (TID-19380) DEVELOPMENT OF A FIVE INCH HIGH SPEED PHOTOMULTIPLIER. Quarterly Report No. 1, June 9, 1963–September 9, 1963. F. A. Helvy (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). Sept. 12, 1963. Contract AT(30-1)-3190. 7p.

A description is given of the development of a five-inch high-speed photomultiplier with the following characteristics: (1) small transit time spread; (2) short pulse rise time; (3) uniform collection efficiency over a great fraction of the entrance window area; and (4) low dark current. The initial design of the RCA developmental C70133 tube is complete. An order has been placed for all parts. It is expected that the first tube should be constructed by January 1, 1964. Minor changes will probably have to be made after the first tube is available for test, but no major changes are anticipated. (auth)

37400 (TID-19393) THETA-THETA DIFFRACTOMETER WITH STATIONARY SAMPLE HOLDER. Technical Report No. 2. C. N. J. Wagner (Yale Univ., New Haven. Hammond Metallurgical Lab.). Aug. 1963. Contract AT (30-1)-2560. 16p.

A focusing x-ray diffractometer (called theta-theta diffractometer) with a stationary, horizontal sample was constructed for the study of liquid structures. Two rotary milling machine tables were mounted in a vertical position to drive the x-ray tube and the detector with equal speed or steps in opposite directions. A continuous drive or step drive can be used in conjunction with a ratemeter and recorder, or a printing time-scaler. A high-temperature furnace, a standard sample holder, or a single crystal orienter can be mounted on the stationary front plate of the diffractometer. Using MoKα radiation and a tungsten-powder sample, the maximum deviation of the measured lattice parameter a_{hkl} from the straight line (least square analysis) when plotted as a function of $\cos^2\theta/\sin\theta$ did not exceed a value of Δa corresponding to $\Delta 2\theta° = \pm 0.01°$ over the entire range of the diffractometer (−90° to +155°2θ). (auth)

37401 (UCRL-7361) SOME EXPERIENCES WITH NOBLE-METAL, METAL-SHEATHED THERMOCOUPLES—SECOND REPORT. W. E. Bostwick (California.

Univ., Livermore. Lawrence Radiation Lab.). May 10, 1963. Contract W-7405-eng-48. 22p. (CONF-191-1)

From Society of Automotive Engineering Symposium, Los Angeles, Sept. 1963.

This report covers the period from the fall of 1960 to the present. Items discussed are: (a) effects of method of fabrication on insulation resistance, (b) comparison of beryllia, boron nitride, and thoria with magnesia from an insulation standpoint, (c) effect of position (vertical or horizontal) on thermocouple output, (d) nonhomogeneity of constituent wires, (e) effect of wire size on stability, (f) what happens when a junction opens, and (g) how Pt 10% Rh/Pt thermocouples act below 32°F. Conclusions are as follows: (a) There seems to be no "best" method of fabrication. (b) Boron nitride and thoria are difficult, if not impossible, to fabricate in our configurations. Beryllia is a somewhat better insulator than magnesia, but for temperatures up to 2900°C the improvement is not enough to justify putting up with its toxic hazard. (c) Thermocouples should always be checked and used in a horizontal position if the temperature is high enough to "soften" any of the constituents of an alloy. (d) Care must be taken to avoid such things as kinking or otherwise damaging wire. (e) The larger the wire size, the greater the stability up to a limit of 20 to 30 mils. (f) Excessive Pt 10% Rh/Pt thermocouple output may indicate an open junction. Excessive output and reversed polarity at intermediate temperatures may indicate an open junction. (g) The Pt 10% Rh/Pt thermocouple has limited use down to –150°F. (auth)

37402 (UCRL-10425) A FAST, WIDE-RANGE TIME-TO-HEIGHT CONVERSION SYSTEM. Donald L. Wieber (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 18, 1962. Contract W-7405-eng-48. 32p.

A time-to-height conversion system was developed which is useful for measuring time intervals from 10 psec to 200 μsec. When driven by a mercury-relay pulse generator through appropriate fixed delays, the resolution of the system, FWHM, is 6 psec, the apparent time shift with temperature is less than 2 psec/°C, and the integral linearity is within ±1%. The apparent time distribution through a type 58 AVP photomultiplier tube driven by a mercury-relay pulser was less than 0.3 nsec at a fixed light level equivalent to 10^3 photoelectrons per pulse. The apparent time shift was less than 0.5 nsec for variations from 10^2 to 10^4 photoelectrons per pulse. (auth)

37403 (NP-tr-1061) A FIELD ION SOURCE WITH THIN WIRES OR SHARP METAL EDGES FOR FIELD PRODUCTION. H. D. Beckey. Translated by F. J. Quinn (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Z. Instrumentenk., 71: 51-4 (1963). 14p.

A field ion source is described producing the electric field not in the usual manner by metal tips but by thin wires or sharp metal edges. The advantages of this method of field production for mass spectrometric analyses of mixtures of chemical compounds are discussed in detail. The fields of research are pointed out where the use of emission tips seems to be more advantageous. A simple field ion source provided with a thin wire or edge can also be used for measurement of total and partial pressure. (auth)

37404 IMPROVEMENT OF THE ION TRANSMISSION IN A TYPICAL MASS SPECTROMETER ION SOURCE. Robert J. Conzemius and Harry J. Svec (Ames Lab., Ames, Iowa). J. Appl. Phys., 34: 2486-7(Aug. 1963). (IS-624)

Some methods for improvement of transmission in an ion source are discussed along with their advantages and disadvantages. (R.E.U.)

37405 THEORY OF A RADIO-FREQUENCY PLASMA PROBE FOR ELECTRON-DENSITY MEASUREMENTS IN THE IONOSPHERE AND EXOSPHERE. T. J. N. Boyd (Univ. of Birmingham, Eng.). J. Geophys. Res., 68: 5089-92(Sept. 1, 1963).

The theory of the r-f plasma probe and its use in designing a probe that is as effective as possible in the measurement of electron densities in the ionosphere and exosphere are discussed. Such a probe on the Ariel satellite provided some data. The interaction of the satellite and its medium is discussed in terms of effect on electron density measurements. (R.E.U.)

37406 POWER AND RADIATION FIELD OF A HIGH-POWER X-RAY TUBE WITH LARGE-AREA ANODE SPOT. E.-G. Hofmann (Allgemeine Elektricitats-Gesellschaft, Berlin). Kerntechnik, 5: 321-7(Aug. 1963). (In German)

For irradiation purposes an increasing demand exists for high-power radiation sources in research and industry. In comparison with electron accelerators and isotope radiation sources high-power x-ray tubes with membrane anodes and large-area anode spots show many advantages. The power and the most important properties of the radiation field of such an x-ray tube were evaluated by means of model considerations and compared with experimental results. With complete use of the radiation output the plant has an irradiation power of 15×10^6 rad kg/hr. The possibilities for the construction of still more powerful x-ray plants for large-scale industrial use are examined and proposals for their design are made. (auth)

37407 READING-CHANNEL APPARATUS FOR MEASURING COORDINATES OF PHOTOGRAPHIC TRACKS. L. L. Likhtenbaum, B. N. Moiseev, and V. S. Kaftanov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 3, 32-9(May-June 1963). (In Russian)

A reading-channel automatic measuring apparatus for analysis of bubble chamber photographs is presented. The theoretical foundations of the reading channel for measuring shifts in diffraction gratings are discussed. The reading channel uses a reversible recorder permitting registration from any position of the apparatus. Data are received continuously from the reading channel in standard form and are adaptable for immediate introduction into a computer. (tr-auth)

37408 FOLLOWING-GEAR APPARATUS FOR MEASURING COORDINATES IN PHOTOGRAPHIC TRACKS. B. N. Moiseev, V. I. Lyulevich, and O. P. Fedotor (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 3, 40-8 (May-June 1963). (In Russian)

An automatic following gear projector for determining the coordinates of nuclear particle tracks in bubble chamber photographs is presented. A method for determining linear and angular separation errors that occur in the data is also discussed. The errors do not exceed ±2.5 μ for a speed of 1 min/sec. (tr-auth)

37409 MEASUREMENT OF POWER IN UHF WAVES BY PROBING WITH ELECTRON BEAMS. B. G. Eremin and S. B. Mochener (Inst. of Radiophysics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 3, 108-12(May-June 1963). (In Russian)

A method for measuring the large impulse power of u-h-f waves in a waveguide path is described. The method utilizes the effect of the reflection of electrons from high-

frequency potential barriers. Results obtained from an experimental model are presented. For comparison the power was also measured by a calorimetric method. (tr-auth)

37410 ANALYTICAL MASS SPECTROMETER WITH MODULATED MOLECULAR BEAM. G. D. Tantsyrev, G. V. Karpov, and V. L. Tal'roze (Inst. of Physical Chemistry, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 3, 118-21(May-June 1963). (In Russian)

A mass spectrometer for the analysis of a gas in the form of a molecular beam is described. The apparatus was developed on the basis of the mass spectrometer MS-2M. In the system the formation and modulation of the molecular beam were accomplished directly in the ion source. For measuring the ion current an electronic multiplier was used and the output was switched into an amplifier and a phase-sensitive detector. The sensitivity of the apparatus in the absence of background was 10^{-3}%, but 10^{-2}% in the presence of background. Use of a modulated beam reduced the background by an order of magnitude. (tr-auth)

37411 AUTOMATIC SCANNING OF THE MAGNETIC FIELD OF MASS SPECTROMETER MI-1305. V. I. Zubkov and A. M. Ivanov. Pribory i Tekhn. Eksperim., No. 3, 182-3(May-June 1963). (In Russian)

A device for the automatic alteration of the magnetic field of the mass spectrometer MI-1305 is described. A scanning block permits automatic recording of recurrent mass spectra in any mass interval of the selected range. The apparatus is distinguished from earlier devices by simplicity of construction and a larger range for recording spectra. (tr-auth)

37412 LIQUID-HELIUM TEMPERATURE REGULATOR. C. Blake and C. E. Chase (Massachusetts Inst. of Tech., Lexington). Rev. Sci. Instr., 34: 984-7(Sept. 1963).

An electronic regulator is described that is capable of controlling the temperature of a liquid-helium bath within ±10 μdeg for a few minutes and reducing long-term drift to less than 40 μdeg/h. With occasional adjustment, the temperature can be indefinitely maintained within ±10 μdeg. The circuit is designed to be used with a resistance thermometer bridge previously described. The error signal from the bridge is displayed on a meter, so that the bridge can be balanced without use of an oscilloscope and the performance of the regulator can be continuously monitored. (auth)

37413 TWO-COMPONENT MICROBALANCE FOR MEASURING THE FORCES ON ION-BOMBARDED SURFACES. Vernon L. Rogallo and Howard F. Savage (Ames Research Center, Moffett Field, Calif.). Rev. Sci. Instr., 34: 988-91(Sept. 1963).

A two-component null-type microbalance was developed to measure forces due to ion bombardment on a surface. The balance employs the principle of the attracted disk electrometer. The sensitivity can be adjusted by simply changing the location of the center of gravity. Measurements of a few micrograms of force in two perpendicular directions can be made simultaneously. (auth)

37414 ELECTRONIC VARIABLE DELAY FOR TRACING CHARACTERISTIC CURVES OF COINCIDENCE CIRCUITS AND TIME-TO-HEIGHT CONVERTERS. Meir Birk, Quentin A. Kerns, and Thomas A. Nunamaker (Univ. of California, Berkeley). Rev. Sci. Instr., 34: 1026-8 (Sept. 1963). (UCRL-10784)

Automatic tracing of characteristic curves of coincidence circuits and time-to-height converters was accomplished by utilizing a tunnel diode circuit. which provides an electrically controlled time delay continuously varying from 30 to 65 nsec. An input pulse starts a current ramp through the tunnel diode, which generates an output pulse on triggering. The moment of triggering, however, is programmed by a control voltage which dictates the instantaneous value of the initial current flowing through the tunnel diode. Measurements of the delay vs control voltage relationship show no deviation from linearity greater than the experimental error of ±15 psec. Time jitter, characterized by the full width at half-maximum of the output-pulse time distribution, is less than 30 psec. A coincidence resolution curve displayed on the screen of an oscilloscope and a height-vs-time curve of a time-to-height converter traced by an X-Y recorder are shown. (auth)

37415 PRESSURE MEASUREMENTS BELOW 10^{-10} TORR WITH BAYARD-ALPERT AND MAGNETRON GAUGES. Franklin L. Torney, Jr. and Frank Feakes (National Research Corp., Cambridge, Mass.). Rev. Sci. Instr., 34: 1041-3(Sept. 1963).

Below 1×10^{-10} Torr, pressure measurement by means of Bayard-Alpert type ion gages is complicated by the existence of a current associated with soft "x rays." The precise measurement of a true ion current requires precise determination of the so-called x-ray limit of each gage. The present work describes the use of a Bayard-Alpert gage containing a modulating electrode (after the design of Redhead) to measure pressures below 10^{-10} Torr. Magnetron-type gages, which do not have x-ray limitations, were then compared directly with the Bayard-Alpert gages. In addition, gage comparisons were carried out in a dynamic system involving pressure ratios across a capillary. Both series of experiments showed that the output current of the magnetron gage was a power function (exponent 1.6) below approximately 2×10^{-10} Torr (N_2). In the latter work it was possible to make measurements to below 1×10^{-12} Torr N_2 equivalent. (auth)

37416 LOW NOISE NUCLEONIC PREAMPLIFIER. D. R. Heywood and B. L. White (Univ. of British Columbia, Vancouver). Rev. Sci. Instr., 34: 1050-1(Sept. 1963).

A low-noise nucleonic preamplifier was designed to utilize the low noise characteristics of a triode-connected E810F/7788 pentode. Its noise performance was measured in terms of equivalent input noise charge and compared with the FWHM values of the output pulse spectrum. The FWHM values are plotted as a function of τ with the external capacitance as parameter. (D.L.C.)

37417 A NEUTRON DIFFRACTOMETER. I. I. Yamzin, Yu. S. Kuz'minov, V. E. Staritsyn, and E. I. Mal'tsev (Inst. of Crystallography and Inst. of Technical Physics, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 234-6(Sept.-Oct. 1963).

The design and specifications are given for a newly developed neutron diffractometer. The diffraction pattern of polycrystalline yttrium ferrite is shown. (R.E.U.)

37418 IONIZATION DEVICES. (to Westinghouse Electric Corp.). British Patent 936,377. Sept. 11, 1963. Priority date Feb. 10, 1961, United States.

A device to measure low pressures down to at least 10^{-10} mm Hg by producing and detecting ions in gases is patented. The device consists of an envelope to receive the gas, an electron source, and electrodes for accelerating the electrons to energies high enough to ionize the gas atoms and for collecting the ions. The electron source is a semiconducting material such as silicon carbide having a band gap of less than ½ of the band gap of the material and having a rectifying junction formed in it. A reverse bias is applied across the junction to create a high internal

electric field to excite electrons to energies greater than the electron affinity of the material. The sensitivity of the device may be increased by passing the electrons through an electron multiplier before entering the ionization space. (M.P.G.)

Radiation Detection

Refer also to abstracts 37012, 38021, 38039, 38040, 38041, and 38042.

37419 (TID-17630) GAMMA DETECTION EFFICIENCY CALCULATIONS FOR ANNULAR AND WELL TYPE SODIUM IODIDE CRYSTALS. U. C. Mishra, S. S. Brar, and P. F. Gustafson (Argonne National Lab., Ill.). Oct. 1962. Contract [W-31-109-eng-38]. 28p. (UAC-6996)

Calculations are presented for the detection efficiency of annular and well-type sodium iodide crystals of commercially available types for gamma energies from 0.1 to 6 Mev. It is possible to read values up to 100 Mev energy by the method described. For annular crystals, calculations are presented for different outer dimensions but a fixed annular diameter, to show the effects of various parameters on detection efficiency; from this, it is easy to select the anticoincidence shield for a given central detector. For well crystals, the effects of well dimension for a given outer geometry and a given position of source inside the well are also presented. Effects of source position inside the well for a crystal of fixed dimensions are discussed. All calculations were made for a point source on the axis of the crystal, by means of the IBM-1620, using either the 19-point or the 25-point Weddle Rule for numerical integration. The results are compared with the values obtained by others. (auth)

37420 (WCAP-2382) MINIATURE NEUTRON DETECTOR DEVELOPMENT. Final Report. [Period Covered]: June 1961–September 1963. J. Weisman, ed. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Sept. 16, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-2827. 45p.

Work on the development of miniature silicon carbide neutron detectors undertaken in the period from June 1961 to September 1963 is summarized. The development program was successful in producing good silicon carbide charged particle detectors. The detectors were shown to be capable of counting 4.5-Mev α particles up to 700°C and U^{235} fission fragments up to 800°C. By coating the detectors with a U^{235} film, they were shown to be suitable for neutron detection. Radiation damage studies showed that the damage can be partly annealed. Considerable annealing occurs at 100 to 200°C with additional annealing up to 600°C and moderate additional annealing at 800°C. Current information indicated that the lifetime of these detectors in the core of a power reactor would be between 100 and 1000 sec when the maximum detector temperature is limited to 800°C. There is evidence that very substantially improved lifetimes can be obtained by use of annealing temperatures in excess of 1000°C. This appears feasible and an effort to reach this goal is being undertaken. (auth)

37421 PULSE SIZE WHEATSTONE BRIDGE FOR THE CALIBRATION OF SCINTILLATION SPECTROMETERS. R. Patzelt (Österreichischen Studiengesellschaft für Atomenergie, GmbH, Vienna). Acta Phys. Austriaca, 16: 245-8 (1963). (In German)

A Wheatstone bridge for the calibration of scintillation spectrometers is described that makes possible calibrations with an error of 1‰ because of its accuracy and time constancy. The principle of the circuit is discussed, and then the circuit is described in some detail. The principle of the method is that there is not only a linear relation between pulse size and compensation voltage but that, after the addition of an additional zero point corrector, both the pulse voltage and compensation voltage are absolutely equal. (J.S.R.)

37422 AVOIDANCE OF DIRECT CURRENT VOLTAGE DISPLACEMENTS IN THE TRANSMISSION OF HIGH PULSE RATES. F. May (Österreichische Studiengesellschaft für Atomenergie, GmbH, Vienna). Acta Phys. Austriaca, 16: 265-8(1963). (In German)

The problem of avoiding direct current voltage displacements in the transmission of high pulse rates is illustrated by a discussion of the principles and properties of an energy spectrometer. The conditions for avoidance of direct current displacements are derived. The displacements measured in the Co^{60} spectrum with a NaI crystal were −1 v without parallel diode, +4 v with diode but without series resistance, and 0 v with diode and series resistance $R_1 = 30$ kohm. The transmission time constant of the amplifier was 10 μsec. (J.S.R.)

37423 HIGH-TENSION EQUIPMENT WITH CORONA STABILIZERS. R. Patzelt (Osterreichische Studiengesellschaft für Atominergie GmbH, Vienna). Atompraxis, 9: 278-81(July 1963). (In German)

High direct tensions for proportional and flow counters with a current consumption of less than 1 μa can be produced reliably and cheaply with corona stabilizers. The maximum constancy is 1‰, which meets normal requirements. Simplicity of construction is shown in a description of two devices, one for 0 to 4500 v, the other for 300 to 800 v; both can easily be made with standard laboratory equipment. (auth)

37424 A ROTATING CRYSTAL SPECTROMETER WITH A MECHANICAL PRESELECTOR OF NEUTRON ENERGIES. G. Quittner and Ch. Schittenhelm (Osterreichische Studiengesellschaft für Atominergie GmbH, Vienna). Atompraxis, 9: 281-5(July 1963). (In German)

A rotating-crystal spectrometer for inelastic scattering of thermal neutrons is described. A low energy of incoming neutrons, which is advantageous from the point of view of resolution, requires some means for removing higher-order neutrons. This is achieved by a mechanical rotor preselector, which is described. (auth)

37425 A PRECISION IRON-FREE $\pi\sqrt{2}$ BETA-RAY SPECTROMETER OF 35-CM OPTIC CIRCLE RADIUS. J. L. Wolfson, W. J. King, and J. J. H. Park (National Research Council, Ottawa). Can. J. Phys., 41: 1489-1518 (Sept. 1963). (NRC-7513)

An air-core, high-resolving-power, high-luminosity, double-focusing spectrometer of the high-aperture type is described. Focusing up to the fourth order in the axial departure angle is achieved with the use of three pairs of magnet coils. A compact coil structure is devised that enables electrons up to 2.5 Mev in energy to be focused without undue rise in conductor temperature, thus preserving the feature of high precision in the measurement of relative electron momenta. For point sources the instrument is designed to achieve resolutions of 0.01%, 0.1%, and 1.0% momentum, at transmission values of 0.08%, 0.38%, and 1.2%, respectively. The use of a curved exit slit enhances the luminosity of the instrument by permitting the use of long sources. The narrowest experimental line width attained is 0.014% in momentum at half the maximum intensity, at a

transmission of 0.06% and using a source 0.1 min in width. (auth)

37426 CORRECTION FACTORS FOR NEUTRON FLUX MEASUREMENTS WITH CADMIUM-COVERED COBALT WIRES. T. A. Eastwood, E. Matyas, and D. J. Hnatowich (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 41: 1519-23(Sept. 1963). (AECL-1806)

Correction factors are determined that represent the effects of thermal-neutron transmission and epithermal-neutron absorption by Cd, in measurements of neutron fluxes by means of Cd-covered Co wires. (T.F.H.)

37427 A DEVICE FOR THE DETERMINATION OF THE RESOLUTION TIME OF COUNTER ARRANGEMENTS WITH GEIGER-MUELLER COUNTERS. G. Moll (Hahn-Meitner-Institut für Kernforschung, Berlin). Elektron. Rundschau, No. 4, 176-8(1963). (In German)

The resolution time of a counter device is equal to the smallest time separation of pulses that can be made by it. The device described is introduced between counter tube and counting device, accumulates these pulse gaps as electrical magnitudes in a minimum value accumulator, and indicates them. An additional gear in the apparatus is not necessary. The sensitivity is 50 mv. Resolution times between 50 and 500 μsec can be measured with an error of ±15 μsec. (tr-auth)

37428 A GAMMA SCINTILLATION SPECTROMETER WITH CONSTANT RELATIVE CHANNEL WIDTH. H. W. Fricke. Elektron. Rundschau, No. 6, 295-8(1963). (In German)

The principles of gamma spectrometry were explained. A new method in which the gamma spectrum was scanned with a constant relative channel width was then described. Actually, the spectrum was induced over the strongly focused channel (gain-scanning method). Therefore, a greater scannable energy range was given, and the spectra thus obtained are free of distortions produced by previous methods (sliding channel method). (tr-auth)

37429 NEW TECHNIQUE FOR IDENTIFYING PARTICLES OBSERVED BY A SCINTILLATION COUNTER. W. Gersch (Columbia Univ., New York). J. Appl. Phys., 34: 823-6(Apr. 1963).

A new technique is offered to determine the quantity of radioactive particles observed by a scintillation or proportional counter when the distribution of the source particles vs particle energy is immersed in the distribution of the background particles. The particle identification problem is interpreted from the point of view of a parameter estimation problem in mathematical statistics in the following way: assume there are M events, where an event is the occurrence of a scintillation counter pulse, M is a known number, N of these events are associated with the desired source particles and the scintillation counter output is source plus background. The remaining (M – N) events consist of background alone. The background statistics are assumed known and the source pulse amplitude distribution is assumed known to within K distribution parameters. One number, the amplitude of the counter response, is observed for each of the M events. The problem is to estimate N. There are (K + 1) unknown parameters: the number N and the K unknown parameters of the source pulse distribution. The problem is solved by what is essentially a method of moments technique. The estimation procedure has desirable statistical properties for large N and M in that the estimate of N is asymptotically unbiased and that the relative variance of the estimate of N asymptotically goes to zero. Implementation of this technique supplants the conventional multichannel pulse-height analyzer with digital recording of the individual pulse count amplitudes and subsequent data processing by a modest size digital computer. (auth)

37430 RESOLUTION STUDY OF PHOTOGRAPHIC THERMAL NEUTRON IMAGE DETECTORS. Harold Berger (Argonne National Lab., Ill.). J. Appl. Phys., 34: 914-18(Apr. 1963). (ANL-FGF-350; UAC-6734)

The high contrast resolving power of several photographic thermal neutron image detection methods was experimentally determined. For the most part, the comparisons between the different imaging techniques were made after optimizing each technique for resolution capabilities. The resolution was studied by determining the minimum hole separation in an almost totally absorbing object that could be resolved by a number of observers on neutron radiographs made by each method. From the standpoint of resolution, the best methods employed thin gadolinium metal screens, compressed Li^6F powder, and a thin B^{10} layer covered with a vapor deposited ZnS (Ag) phosphor in techniques in which the photographic film and screen were exposed together to the low gamma content, 1.05 Å monochromatic neutron beam. A transfer of an image carrying radioactive gold screen to film also yielded resolution values in the order of 0.001 in. Evidence is presented to explain many of the observed resolution comparisons on the basis of the average penetrating power of the photographically effective radiation emitted from the converter screen. A technique for measuring this property on a comparative basis is described. (auth)

37431 A MODIFIED DESIGN OF A HIGH TEMPERATURE ARGON BETA-RAY DETECTOR FOR GAS CHROMATOGRAPHY. R. Mahadeva Iyer and J. P. Mittal (Atomic Energy Establishment, Trombay, India). J. Chromatog., 11: 404-5(July 1963). (In English)

The design of an ultra sensitive detector for gas chromatographic work, whose operation is based on the unique ionization properties of argon gas, was modified. The metal column is directly connected to the metal detector body using a swagelok coupler without any insulating material in between. High voltage is applied through an extended spark plug probe and the collector electrode is isolated from the body of the detector by a porcelain insulated Anticorona plug. The detector is relatively insensitive to changes in temperature, pressure, and gas flow, and as little as 10^{-12} moles of most organic substances can be detected. (P.C.H.)

37432 COUNTER WITH SELECTIVE EFFECTIVENESS FOR REGISTERING EMISSIONS WITHOUT RECOIL GAMMA RAYS. K. P. Mitrofanov, N. V. Illarionova, and V. S. Shpinel (Moscow State Univ.). Pribory i Tekhn. Eksperim., No. 3, 49-54(May-June 1963). (In Russian)

A detector that has selective effectiveness for the Sn^{119} 23.8-kev gamma rays for registering emissions without recoil is presented. The principle of operation consists in registering internal conversion electrons that arise from resonance-excited nuclei of tin bearing compounds by means of an internal geiger counter. The linear absorption can be calculated from the resonance detector measurements. It is shown that the linear absorption width is affected less than for ordinary registration. Experimental results compared with plane resonance counters corroborates the accuracy of the calculations. Maximum measurements exceeding the calculation of resonance gamma rays above background was 250%. The effectiveness of the counter for registering emissions without the recoil of the Sn^{119} gamma ray was 15% and for 25-kev roentgen rays, not greater than 0.2%. (tr-auth)

37433 APPLICATION OF THRESHOLD CHERENKOV DETECTOR FOR SEPARATION OF π AND μ MESONS IN MESON BEAMS. V. D. Bobrov, V. G. Varlamov, Yu. M. Grashin, B. A. Dolgoshein, V. G. Kirillov-Ugryumov, V. S. Roganov, and A. V. Samoilov. Pribory i Tekhn. Eksperim., No. 3, 55-7(May-June 1963). (In Russian)

A Cherenkov detector with aqueous radiator and diffusion deflector is used for the separation of slow π and μ mesons. The detector has an efficiency of nearly 100% for μ mesons and not less than 70% for π mesons. It is possible to reduce the content of π mesons in a μ meson beam by a factor of 10. (tr-auth)

37434 MULTIFILAMENT NEUTRON DETECTOR WITH NON-OVERLOADING PREAMPLIFIER. S. S. Moskalev, Yu. V. Adamchuk, and S. K. Sotnikov (Inst. of Atomic Energy, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 3, 58-60(May-June 1963). (In Russian)

A large-area multifilament neutron detector using $B^{10}F_3$ is described. The detector is used for the study of neutron total cross sections in time-of-flight spectrometers with a neutron source from an electron linear accelerator. The non-overloading preamplifier prohibits overloading in the instrument due to the energetic impulse of gamma rays that arise in the linear accelerator. (tr-auth)

37435 ON TRACK WIDTHS IN CONVECTION CHAMBERS. N. G. Volkov, V. K. Lyapidevskii, and I. M. Obodovskii (Moscow Inst. of Engineering Physics). Pribory i Tekhn. Eksperim., No. 3, 61(May-June 1963). (In Russian)

The schematic diagram of a controllable photomultiplier tube for use with convection chambers is presented. Alpha particles are emitted in a collimated beam parallel to the bottom of the chamber. The ions travel in the sensitive medium under the influence of the electric field. The distance between the source and the bottom of the chamber varies from 2.5–5.0 cm, and the electric field ranges from 5 to 600 v/cm. The track widths are determined with the aid of a microphotometer. (C.E.S.)

37436 MEASUREMENT OF RAPID BUBBLE GROWTH IN PROPANE CHAMBERS. Yu. A. Aleksandrov, G. S. Voronov, and N. B. Delone (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 3, 62-3(May-June 1963). (In Russian)

The rate of growth in superheated propane was measured at 70.34°C and a pressure of 17.1 ± 0.14 atm. The chamber was exposed to a Co^{60} gamma source. Curves illustrating the bubble radius as a function of time were presented. The time of bubble initiation was determined with an accuracy of $\pm 1.5 \times 10^{-3}$ sec. An equation for the rate of bubble emergence was also presented. (C.E.S.)

37437 AUTOMATIC DEVICE FOR MEASURING RADIOACTIVE WIRES. M. P. Sokolov. Pribory i Tekhn. Eksperim., No. 3, 66-70(May-June 1963). (In Russian)

An automatic apparatus for measuring the neutron flux along reactor channels by activating an indicator is presented. A length of wire is exposed to the neutron flux and is then reeled through a radiation detector. Measurements of the exposed portion of wire can fluctuate over a wide range. Impulses from the radiation detector are amplified, discriminated, and fed into a calculator. The information is processed and appears in final form on a printing apparatus attached to the calculator. Schematic diagrams of the instrument are included. (tr-auth)

37438 SMALL-ANGLE CHAMBER WITH PROPORTIONAL COUNTER FOR ROENTGEN RADIATION. D. A. Goganov, E. A. Porai-Koshits, and Yu. G. Sokolov (Inst. for the Chemistry of Silicates, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 3, 155-60(May-June 1963). (In Russian)

In order to increase the sensitivity of small-angle apparatus for the detection of very low intensity x rays scattered from glass a proportional counter was constructed. In the new apparatus the x rays emitted at small angles from glass with very small heterogeneity were detected. Several roentgenograms were presented. (tr-auth)

37439 NANOSECOND SCINTILLATION COINCIDENCE SPECTROMETER SYSTEM WITH HIGH RELIABILITY. L. S. Beller (Atomics International, Canoga Park, Calif.). Rev. Sci. Instr., 34: 1001-6(Sept. 1963).

A low-energy scintillation coincidence system capable of few-nanosecond resolution and very low timing jitter is described. Saturating circuit techniques are used to make the performance nearly independent of tube parameters, resulting in stable and reliable performance over periods of months. (auth)

37440 SENSITIVE TRITIUM COUNTING WITH A PROPANE PROPORTIONAL COUNTING SYSTEM. G. W. Eulitz (Univ. of California, Los Angeles). Rev. Sci. Instr., 34: 1010-14(Sept. 1963).

Comparison of the minimum detectable amount of tritium by different counting devices shows that proportional gas counting is the most sensitive method at the present time. A new method of tritium proportional gas counting using propane as counting gas is described. The propane is formed by hydrogenation of propyne with palladium oxide as a catalyst. Using a 2.5-liter counter filled with propane at 2.2 atm pressure requires a sample size of half a mole of H_2O or H_2. For a background of 5.3 cpm, this results in a minimum detectable concentration, without isotopic enrichment of tritium, of 3 TU equal to $\pm 2\sigma$ for a counting time of 1000 min, where 1 TU = T/H ratio of 10^{-18}. (auth)

37441 INTERACTION OF FISSION FRAGMENTS WITH ORGANIC SCINTILLATORS. Donald L. Horrocks (Argonne National Lab., Ill.). Rev. Sci. Instr., 34: 1035-40(Sept. 1963).

A pulse-shape discriminator circuit was used for the measurement of the pulse heights of the slow components of light pulses from organic scintillators excited by different types of particles: electrons, protons, alpha particles, and fission fragments. Three types of organic scintillators were employed: a crystal (stilbene), a liquid (7 g PPO and 0.5 g M_2-POPOP in 1 liter of toluene), and a plastic (NE-150). The relationship of the pulse heights of the slow components for excitation with electrons, protons, and alpha particles was similar for all three scintillators. However, fission fragments produced a slow component pulse height similar to protons in stilbene and the plastic but more like electrons in the liquid. The pulse-height distributions of total light pulses from the scintillators excited by the alpha and spontaneous fission emissions of Cf^{252} were measured. The alpha-particle and fission-event spectra were resolved only with the liquid scintillator giving a pulse-height spread of the fission distribution peak of 40%. From the maximum of the fission spectra it was calculated that the most probable energy of fission produced the same pulse height as an electron with 1/75th that energy would produce. The alpha particles and the fission events were counted with 100% efficiency and a value of 31.0 ± 0.5 was obtained for the alpha to fission disintegration ratio of Cf^{252}. (auth)

37442 ON IDENTIFICATION OF PARTICLES BY THE PHOTOGRAPHIC EMULSION TECHNIQUE. P. Ya. Chas-

nikov, Z. V. Anzon, Zh. S. Takibaev, and I. S. Streltsov (Inst. of Nuclear Physics, Kazakh Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 29-37 (Aug. 1963). (In Russian)

Particles with 1.5 Bev $\leq \rho\beta c \leq$ 2.5 Bev whose nature cannot be determined by scattering or ionization measurements are identified by the δ-electrons produced by them. It is shown that such particles produced in 9 Bev proton-neutron interactions are mainly π mesons. The possibility that particle energies in the 1 to 17.5 Bev range measured on the basis of multiple Coulomb scattering may be too large is discussed. In big cells the second Coulomb scattering difference and the ratio of the third coordinate difference to the second are found to appreciably differ from the theoretical value. It seems advisable to measure $\rho\beta c$ in such cells in which ρ (ratio of third measured difference to second) lies between 1.2 and 1.5, the total error in $\rho\beta c$ being minimal. (auth)

37443 HOW TO DETECT AND MEASURE RADIATION. Harold S. Renne. Indianapolis, Howard W. Sams and Co., Inc., 1963. 160p. $3.95.

The properties of nuclear radiation and its effects are reviewed. The various types of instruments used to detect and measure radiation are described and applications in diversified fields are discussed. (C.H.)

37444 A STUDY OF THIN SOLID STATE PARTICLE DETECTORS. Charles Nolan Inskeep. Thesis, Knoxville, Tenn., Univ. of Tennessee, 1963, 165p.

An investigation was made of semiconductor particle detectors. Surface barriers were studied, and a method was found for forming a rectifying barrier on p-type silicon. A technique was developed for determining the depths of diffused layers as shallow as 0.1 micron. This method also provides a way to obtain dopant concentration profiles in the study of diffusion processes. A study of silicon surface effects was carried out. A method was developed for removing inversion layers from the surfaces of p-type silicon. A number of very thin silicon dE/dx detectors were built and tested. Test results are presented together with a discussion of the fabrication methods developed during this program. One result of this development was the development of a method for inhibiting contact injection of minority carriers into high-resistivity p-type silicon. (Dissertation Abstr.)

ISOTOPE SEPARATION

37445 (AEC-tr-5986) ISOTOPE SEPARATION AND ENRICHMENT. K. Bier, W. Fischer, and G. Dickel. Translated by L. L. Smith (Savannah River Lab., Aiken, S. C.) from Chem.-Ing.-Tech., 34: 580(1962). 8p.

The enrichment of U^{235} by the partition diffusion method and the problems involved are discussed. The state-of-the-art of uranium isotope separation by the gas centrifuge and partition jet methods is described briefly. The use of ion migration in the pre-enrichment of Ca^{46} in Ca^{47} prior to calutron enrichment is considered, and the migration model for explaining the measured mass effects is discussed. The problem of deriving a useful theory of thermal diffusion separations is considered; the invariant theory of the separative tube cascade was developed which uses separation work rather than separation efficiency. The results of centrifugal separation of argon isotopes in a vortex tube are given which were used to derive the separation mechanism. (D.L.C.)

37446 ELECTROMAGNETIC SEPARATION OF RADIOACTIVE ISOTOPES. M. J. Higatsberger (Österreichische Studiengesellschaft für Atomenergie, GmbH, Vienna). Acta Phys. Austriaca, 16: 234-44(1963). (In German)

The properties of the isotope separator constructed by the Österreichische Studiengesellschaft für Atomenergie are described. The procedures for isotope separation before and after irradiation in a reactor or cyclotron are given. The isolation and identification of fission products were carried out by three different methods, which are described briefly. (J.S.R.)

37447 THE FRACTIONATION OF CARBON ISOTOPES BY ION EXCHANGE EMPLOYING A FORMIC ACID SYSTEM. Charles N. Davidson, Charles K. Mann, and Raymond K. Sheline (Florida State Univ., Tallahassee). J. Phys. Chem., 67: 1519-24(July 1963).

The fractionation of carbon isotopes was achieved by ion-exchange displacement chromatography with a CH_3COO^-–HCOOH–HCl system on strongly basic Dowex 2 resin. Experiments utilizing C^{14}-labeled formic acid solutions indicated the lighter C^{12} to be enriched in the resin phase. The separation factor, $K = (C^{12}/C^{14})_r/(C^{12}/C^{14})_s$, was measured as a function of temperature and found to increase from 1.0032 at 35.4° to 1.0062 at 6.0°. From the temperature-dependence of K, ΔH^0 for the equilibrium $HC^{12}OOH_s + HC^{14}OO_r^- \rightleftharpoons HC^{14}OOH_s + HC^{12}OO_r^-$ was calculated to be −4.3 cal/mole, and ΔS^0 was found to be -6.3×10^{-3} cal/mole-degree at 25°. K varied from 1.0028 for resin with 2% DVB content to 1.0059 for Dowex 2 × 10. The subsequent decrease to 1.0055 for resin with 24% DVB was explained by dehydration effects. An extended run utilizing multiple-column operation resulted in enrichment of C^{14} by a factor of almost two in the leading fractions. (auth)

37448 THERMAL DIFFUSION IN TERNARY GAS MIXTURES. F. van der Valk. Thesis, Amsterdam, Univ. of Amsterdam, 1963. 69p.

This thesis concerns the thermal diffusion (TD) in gaseous mixtures of two isotopes with one non-isotopic component. The rigorous theory of multicomponent mixtures is elaborated, giving a convenient expression for the TD factor of two components in a polynary mixture. The former experiments are being compared with theoretical calculations. The new experiments concern measurements on the mutual affect on the TD of addition of two binary isotopic mixtures to each other, and the direct measurement by means of a swing separator of the TD factor for systems formerly investigated in a TD column. The following gases were investigated: mixture of He^3–He^4; natural Ne; mixture of $C^{14}O$–$C^{12}O$; C_2H_4; $C_2H_2D_2$; C_2H_4. (RCN)

MATHEMATICS AND COMPUTERS

37449 (JINR-P-1281) O SLUCHAINYKH PEREMESHCHENIYAKH NA SFERE I V PROSTRANSTVE LOBACHEVSKOGO. (On Accidental Displacements on the Sphere and in the Lobachevsky's Space). R. M. Muradyan (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 6p.

The problem of the wandering curve in space with positive as well as negative curvature is developed. The analogous problem in Euclidean space was developed earlier by Cleaver, Rayleigh, and others. The development is also interesting from the point of view of the correlation between the transformations in Meler-Fok and Lobachevsky space. (tr-auth)

37450 (WCAP-6016) NUCLEAR MATERIALS CONTROL SYSTEM (NMCS). PHASE II. EVALUATION OF COMPUTERS FOR NUCLEAR MATERIALS CONTROL. A. R. Fritsch, H. Ginsburg, and R. J. Madden (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Aug. 1, 1959. Contract AT(30-1)-2176. 60p.

A medium-sized digital computer, with auxiliary data-logging equipment, is recommended for use in the Nuclear Materials Control System (NMCS). For the assumed nuclear complex, it was concluded that a manpower reduction of about eight men may be achieved at a capital cost of about $580,000 and an additional annual operating expense of $140,000. The increased costs can be justified by the expected improvements in NMCS operating efficiency and the greater availability of information. (auth)

37451 REPRESENTATION THEORY FOR NONUNITARY GROUPS. John O. Dimmock (Raytheon Research Div., Waltham, Mass.). J. Math. Phys. (N. Y.), 4: 1307-11(Oct. 1963).

The representation theory for nonunitary groups is formulated following the same development used in the case of unitary groups, and the orthogonality relations for the corepresentation matrices are obtained. The general considerations of Wigner are used to show how the irreducible corepresentations of a nonunitary group can be obtained from the irreducible representations of its unitary subgroup. (auth)

37452 NOTE ON THE GLOBAL VALIDITY OF THE BAKER-HAUSDORFF AND MAGNUS THEOREMS. James Wei (Princeton Univ., N. J. and Socony Mobil Oil Co., Paulsboro, N. J.). J. Math. Phys. (N. Y.), 4: 1337-41 (Oct. 1963).

The domain of global validity of the Baker-Hausdorff and its Magnus continuous analog is examined. Both theorems are valid globally for free Lie algebras of formal power series. For algebras that are not free, however, both theorems are locally but not globally valid. Examples are given, and necessary and sufficient conditions for global validity are discussed. A superior representation in terms of a finite product of exponentials is also given. (auth)

37453 GENERALIZED NORMAL SOLUTIONS OF THE BOLTZMANN EQUATION. Lawrence Sirovich (New York Univ., New York). Phys. Fluids, 6: 1428-39(Oct. 1963).

Solutions of the linearized Boltzmann equation that may be found from finite moment equations are studied. A general solution to this problem is found and its properties discussed. A more restrictive class of such solutions, called generalized normal solutions, are then uncovered. These constitute a wide class of solutions in any desired number of moments. The governing equations are rendered determinate by exact expressions relating higher moments to the distinguished moments. In certain circumstances the initial data must be altered, and the resulting ersatz initial data used in connection with the equations. A case in point is the usual normal solution of the Hilbert-Chapman-Enskog theory. The ersatz initial data then renders the latter into an exact asymptotic theory. In addition higher moment systems are discussed in detail. It is shown that the generalized normal solutions are by no means a comprehensive class. Exact solutions of the Boltzmann equation, which are also exact solutions of the Euler equations, the Navier–Stokes equations, the Burnett equations, and the Thirteen moments equations (among others), are exhibited. Furthermore, these can satisfy the Boltzmann equation in an infinite variety of ways. (auth)

37454 SUPERCONDUCTIVE SWITCHING. J. M. Lock (Royal Radar Establishment, Malvern, Australia). Rept. Progr. Phys., 25: 37-62(1962).

The main features of electronic computers and of superconductivity are reviewed, and the development and use of computer switches that operate on the superconductive transition is outlined. The cryotron and the Crowe cell receive particular attention. (D.C.W.)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

37455 (BMI-X-258) PREPARATION OF URANIUM CARBO-NITRIDES BY ARC MELTING. W. Chubb and D. L. Keller (Battelle Memorial Inst., Columbus, Ohio). Sept. 13, 1963. Contract W-7405-eng-92. 10p.

Alloys of uranium containing 1 to 5 wt % carbon were melted under a partial pressure of 1/3 atmosphere of nitrogen. Carbon and nitrogen analyses of the products show that stoichiometric U(C,N) may be obtained at this pressure using an alloy initially containing slightly less than 4.2 wt % carbon (final composition, 95 wt % uranium, 4.1 wt % carbon, 0.9 wt % nitrogen). Alloys containing more carbon will absorb less nitrogen; alloys containing less carbon will absorb more nitrogen; but at 1/3 atmosphere pressure of nitrogen only one initial carbon content will result in stoichiometric U(C,N). (auth)

37456 (GEAP-3902) PROGRAM FOR THE DEVELOPMENT OF PLUTONIUM RECYCLE FOR USE IN LIGHT WATER MODERATED REACTORS. Quarterly Report No. 3. J. G. Carver (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Jan. 5, 1962. Contract AT(04-3)-189. 9p. (EURAEC-355)

The Program fuel element was completed and assembled. Before the element was inserted in the Vallecitos Boiling Water Reactor, preliminary analyses were made on the unclad fuel pellets supplied by Hanford. Due to a high disparity in the Pu/U ratio, the scheduled insertion of the fuel was postponed until after more detailed studies of the composition could be made. After extensive analysis, it was concluded that the fuel was satisfactory for use in the Program. (auth)

37457 (GEAP-3916) PROGRAM FOR THE DEVELOPMENT OF PLUTONIUM RECYCLE FOR USE IN LIGHT WATER MODERATED REACTORS. Quarterly Report, January 1–March 31, 1962. J. G. Carver and M. A. Robkin (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Apr. 15, 1962. Contract AT(04-3)-189. 10p. (EURAEC-357)

The Program Fuel Element was inserted in the Vallecitos Boiling Water Reactor in January, and has achieved an estimated burnup of 860 Mwd/t at the center of the plutonium fuel. Two sets of resonance wires were activated in the fuel element, and the raw data indicate a harder slow neutron spectrum in the plutonium-enriched region than in the uranium-enriched region. Work was begun on an evaluation of inelastic scattering of thermal neutrons in UO_2, and of the possible effects of such scattering on reaction rates in the several plutonium isotopes present. Some of the requirements were established for applying Nelkin's analysis (developed for H_2O) to the calculation of inelastic scattering in UO_2. (auth)

37458 (IS-662) INVESTIGATION OF VIBRATORY POLISHING VARIABLES. E. N. Hopkins and D. T. Peterson (Ames Lab., Ames, Iowa). June 1963. Contract W-7405-eng-82. 17p.

The vibratory polisher has become a useful tool in the polishing of metallographic samples. This investigation established some of the effects of the lap material, weight of sample, number of samples, types of abrasives, and vibrational amplitude on the rate of metal removal and the quality of the polished surface. (auth)

37459 (NAA-SR-Memo-8481) THE EXPERIMENTAL EVALUATION OF FISSION PRODUCT MOBILITY. I. EQUIPMENT AND CALIBRATION STUDIES. A. J. Moses (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 14, 1963. Contract [AT(11-1)-Gen-8]. 24p.

An apparatus is described for use in fission gas mobility studies using post-irradiation annealing techniques. Basically the apparatus comprises a resistance furnace, temperature controlling and recording equipment, gamma ray scintillation spectrometer, and a ceramic sample tube, containing specimen, thermocouple, and pressure gauge. Calibration data are presented for the measurement of fission gas Xe^{133}, taking into account system pressure, temperature, system geometry, and other pertinent factors. (auth)

37460 (NMI-2807) SUMMARY REPORT ON THE STUDY OF BETA TREATMENT OF URANIUM. R. B. Russell and A. K. Wolff (Nuclear Metals, Inc., West Concord, Mass.). Apr. 1, 1963. Contract AT(30-1)-2784. 147p.

A study was made on the effects of beta treatment variables on the texture, grain size, and distortion in unalloyed dingot and ingot uranium. The effects of delta heat treatment, various cooling regimes, recrystallization, etc., were studied. (D.L.C.)

37461 (NYO-8627) [INVESTIGATIONS ON THE INTERACTIONS BETWEEN POINT DEFECTS AND DISLOCATIONS]. Final Report. [Period Covered]: May 1, 1958–August 31, 1963. Doris Kuhlmann-Wilsdorf (Pennsylvania. Univ., Philadelphia and Virginia. Univ., Charlottesville. School of Engineering and Applied Science). Sept. 1963. Contract AT(30-1)-2151. 18p.

Research on dislocation generation by lattice vacancies and on dislocation-point defect interactions resulted in several new concepts for these processes. Procedures were also developed for electrolytically depositing gold foils free of certain defects, and Al crystals grown at high ambient temperatures were found to have a very low dislocation density. (D.C.W.)

37462 (ORNL-TM-647) COMPATIBILITY OF CADMIUM-BEARING MATERIALS WITH THE HIGH FLUX ISOTOPE REACTOR FUEL PLATE CONSTITUENTS. T. D. Watts and K. K. Sinha (Oak Ridge National Lab., Tenn.). Oct. 1, 1963. Contract W-7405-eng-26. 22p.

Some form of cadmium may be required as burnable poison in the filler section of the High Flux Isotope Reactor fuel plates. This requirement necessitated a compatibility study between various cadmium-bearing materials and the filler section constituents, aluminum and B_4C. Pellets containing the cadmium material along with aluminum and B_4C were heat treated for 24 hr at 600°C and the compatibility evaluated on the basis of physical alterations. A low-silica crown glass (19 wt % CdO) showed excellent stability. Anhydrous cadmium sulfate also showed promise. Fabrication experiments on miniature plates demonstrated excellent working characteristics and freedom of blister formation for both materials. The 19 wt % CdO crown glass was selected for use on the basis of better chemical stability than $CdSO_4$. Successful prototype fuel plates were produced using this glass as a burnable poison. (auth)

37463 (TID-17993) STRESS ORIENTATION OF TITANIUM HYDRIDE IN TITANIUM. M. R. Louthan, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [Jan. 1963]. Contract AT(07-2)-1. 11p.

The susceptibility of titanium to stress orientation of hydride precipitates was investigated. It was determined that when hydride precipitation occurred in titanium under an applied tensile stress of 30,000 psi, the hydrides precipitated on the titanium habit plane oriented most nearly perpendicular to the stress axis. Stress orientation of the hydride platelets occurred because the precipitation of the lower density hydride phase perpendicular to the stress axis caused expansion of the matrix in a direction that tended to relieve the applied stress. (auth)

37464 (TID-19394) X-RAY STUDY OF THE STRUCTURE OF LIQUID METALS AND ALLOYS. Annual Progress Report. C. N. J. Wagner (Yale Univ., New Haven. Hammond Metallurgical Lab.). Jan. 1963. Contract AT(30-1)-2560. 8p.

The interference function a(K), which is the Fourier transform of the radial distribution function, is discussed. The construction of a theta-theta diffractometer and of a heating stage for a high-temperature x-ray diffractometer attachment is described. Progress is reported of the x-ray study of liquid mercury. (D.L.C.)

37465 (WAPD-T-1508) THE EFFECT OF CARBON UPON THE CORROSION AND TENSILE PROPERTIES OF ZIRCALOY-2. S. Kass and J. D. Grozier (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). June 1962. Contract AT(11-1)-Gen-14. 31p.

The influence of the carbon content of Zircaloy-2 upon the room and elevated temperature tensile properties and upon the aqueous corrosion performance was studied. The results show that the room temperature tensile and yield strengths are increased with increasing carbon content, but the elevated temperature strength properties are not influenced by carbon concentration. It was also observed that the corrosion resistance decreases with carbon content; however, carbon additions overcome the deleterious effects upon corrosion resistance brought about by slowly cooling Zircaloy-2 through the two-phase, alpha-plus-beta region. (auth)

37466 (FTD-TT-63-174) GRAPHITE CONTAINING REFRACTORY MATERIALS. N. A. Golushko. Translation of "Grafitosoderzhashchie Ogneupory" (a publication of State Scientific-Technical Publishing House of Literature on Crude and Non-ferrous Metallurgy, Moscow, 1962). 138p.

A book is presented on the production problems of graphite-containing refractories. Among the items discussed are the characteristics of the raw materials, their preparation, molding and drying of the products, methods of heat treatment, spoilage and its prevention, service conditions and durability of refractories, and design of intermittent and kiln type furnaces. (D.L.C.)

37467 ATOM EJECTION IN LOW ENERGY SPUTTERING OF SINGLE CRYSTALS OF BCC METALS. G. S. Anderson (General Mills Electronics Div., Minneapolis). J. Appl. Phys., 34: 659-63(Mar. 1963).

The spatial distribution of atoms ejected from low index planes of the bcc metals V, Fe, Nb, Mo, Ta, and W have been studied in detail for bombardment by Hg^+, Xe^+, Ar^+, and Ne^+ ions of energies up to 800 ev. The principal atom ejection directions are the (111) and (100), which are the directions of focusing propagation in bcc crystals. Other atom ejection directions were observed in which momentum focusing is not possible. These are interpreted to be the result of (111) focusons (directed outwardly with sufficient energy) intercepting surface atoms which are not in normal atom sites. For bombardment of (100) surfaces the center spot ([100] ejection) appears above a certain minimum energy which increases in the order Ne, Ar, Xe, Hg. This is true for widely different masses of the target atoms, and seems to be related to the spatial distribution of momenta in the crystal. For heavier bombarding ions the momenta tend to be directed more in the forward direction and the center spot becomes less pronounced than for lighter bombarding ions. (auth)

37468 ANGULAR-DEPENDENT SPUTTERING OF COPPER SINGLE CRYSTALS. J. M. Fluit, P. K. Rol, and J. Kistemaker (FOM-Lab. for Mass Separation, Amsterdam). J. Appl. Phys., 34: 690-1(Mar. 1963).

The dependence of the sputtering yield upon the angle of incidence for copper single crystals by bombardment with 20-kev Ne^+, Ar^+, and Kr^+ ions was measured. The maxima and minima in this dependence, which have been found, can be correlated to a transparency in different directions of the first few lattice planes. An effective collision diameter deduced from the angular dependence of sputtering by Ar^+ ion bombardment on a copper (100) single-crystal surface was found to be 0.39 Å. This value is 3 times larger than the effective collision diameter calculated from the hard sphere approximation for a Bohr potential, taking into account the thermal motion of the lattice particles. (auth)

37469 SELF-PINCH INSTABILITIES IN SOLID SODIUM. R. M. Henson and M. Eisner (Agricultural and Mechanical Coll. of Texas, College Station). J. Appl. Phys., 34: 1886-7(July 1963).

Taylor-type instabilities were observed using sodium as a magnetohydrodynamic model of plasma. The wavelengths were found to be in fair agreement with the theory of Kruskal and Schwarzschild. (auth)

37470 METALLOGRAPHIC STUDIES OF SPUTNIK 4 FRAGMENT. O. F. Kammerer, J. Sadofsky, and D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.). J. Geophys. Res., 68: 5049-57(Sept. 1, 1963). (BNL-6596)

Metallographic analyses were performed on a fragment of steel recovered after the disintegration of Sputnik 4 and on a melted agglomerate found on the fragment. The examination indicated that the material was a hot-rolled carbon steel similar in hardness to a structural steel with a tensile strength of 3.8 to 4.1×10^{10} dynes/cm^2. The major portion of the fragment exhibited a banded structure characteristic of hot-rolled material. The upper surface was probably heated to the melting point which resulted in the formation of a narrow band similar to an as-cast Widmannstaetten microstructure. The melted material at the bottom of the specimen was a porous mass containing several different varieties of inclusions and compounds. (auth)

37471 ON THE IMPROVEMENT OF METALLIC URANIUM FUEL. II. THERMAL CYCLING AND CORROSION TESTS OF EXTRUDED URANIUM RODS AND SOME URANIUM ALLOYS. Kazuo Maruya, Toshio Saito, and Tatsuo Maekawa (Mitsubishi Atomic Power Industries, Inc., Japan). Nippon Genshiryoku Gakkaishi, 5: 572-80(July 1963). (In Japanese)

Uranium alloys were fabricated by a co-reduction process, and thermal cycling tests were carried out. Properties of γ-extruded uranium rods were tested, and their merits were compared with those of alloying specimens. Corrosion tests of uranium and uranium alloys were undertaken in a temperature range of 300 to 600°C. Limitation of corrosion resistivity of uranium alloys is discussed. On γ-extruded

uranium rods, β-oil-quenched specimen showed the smallest growth, warp, and wrinkle after the thermal-cycling tests. After oil-quenching treatment, it was not necessary to follow with an α-annealing procedure. Requirements to reduce thermal-cycling growth by heat treatments were different in each specimen, so the appropriate heat treatments should be considered. Thermal-cycling growth was also large in extremely grain-refined specimens. Weight gain of uranium alloys in oxidation by CO_2 was larger than that of metallic uranium in the temperature range above 550°C. From the standpoints of grain refinement, workability, thermal cycling growth, corrosion resistivity, and neutron economics, U–Nb–Mo, U–Cr–Mo, and U–Zr–Mo ternary alloys are recommended as the uranium fuels. (auth)

37472 THE CONSTITUTIONAL ALTERATIONS AT ELEVATED TEMPERATURES OF CARBOXYNITRIDE AND CARBONITRIDE INCLUSIONS IN URANIUM METAL. George L. Kehl (Columbia Univ., New York) and Eric Mendel. Trans. Am. Soc. Metals, 56: 550-65(Sept. 1963).

The progress of decomposition of two types of nonmetallic inclusions found in uranium metal, namely U(C,N) and U(C,N,O), was investigated at temperatures of 810 and 1090°C. Both types of inclusions are usually surrounded by a second phase rim, and in the case of U(C,N,O), the rim may be only partial. Observations were made by both optical and electronic microscopy, and the changes arising in composition of the rims and cores were determined by several analytical test methods, including x-ray-diffraction analyses of inclusion debris created with an ultrasonic jack hammer. (auth)

37473 BERYLLIUM ALLOYS. Thomas Raine and James Alan Robinson (to Associated Electrical Industries Ltd.). British Patent 933,408. Aug. 8, 1963. Filed June 27, 1961.

A corrosion-resistant Be-base alloy is patented. The alloy consists of 0.1 to 3%, by weight, of Ca, 0.1 to 2% of Zr, Nb, V, or Ti, and the remainder Be, including unavoidable impurities. The preferred proportion of Ca is 1%, and that of Zr, Nb, V, or Ti is 0.5%. The alloy has high neutron transparency and greater strength than Be–Ca alloys. The ternary alloy can be made by conventional powder metallurgical techniques or by consumable-electrode arc melting followed by direct fabrication. (M.P.G.)

37474 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF SINTERED BERYLLIUM OXIDE. (to Pechiney Compagnie de Produits Chimiques et Electrometallurgiques). British Patent 936,004. Sept. 4, 1963. Priority date Dec. 12, 1958, France.

A process for the preparation of sintered BeO is patented. A powder is formed of an anhydrous mixture of "light" BeO and "heavy" BeO. "Light" BeO has a bulk density of 0.2 to 0.3 g/cm^3 and a specific surface area of at least 10^5 cm^2/gm. "Heavy" BeO has a bulk density of 1.0 to 1.2 g/cm^3 and a specific surface area of 5000 cm^2/g. A small proportion of a finely powdered alkaline-earth metal oxide, preferably Ca or Mg oxide, is added to the BeO powder. An alkaline-earth metal salt, such as carbonates, nitrates, and organic salts, may be used instead of the metal oxide. The powdered mixture is crushed to a fineness of at least 20,000 cm^2/gm specific surface area and dried. A binder is added, and the resulting mass is agglomerated and then sintered at a temperature not exceeding 1600°C. (M.P.G.)

37475 PROCESS FOR THE PRODUCTION OF URANIUM MONOCARBIDE. Rudolf Kohlermann, Walter Dubel, and Walter Flurschutz (VEB Hartmetallwerk Immelborn). British Patent 936,007. Sept. 4, 1963. Filed Mar. 31, 1960.

A process for the production of a low-graphite-content UC at relatively low temperatures is patented. A U–C or UO_2–C mixture is carburized in a vacuum at a temperature below 1600°C in a metallic oxide container. The metallic oxide should be one that has substantially no reaction with U, UO_2, and C below 1600°C. Sintered corundum is recommended. The UC produced by the process is very pure, has a very high content of bonded C, and contains no other U–C compounds. (M.P.G.)

37476 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR MEASURING THE ELECTRICAL RESISTIVITY OF LIQUID METALS. Leslie Reginald Blake and Anthony Rainsford Eames (to United Kingdom Atomic Energy Authority). British Patent 936,040. Sept. 4, 1963. Filed Sept. 6, 1960.

An apparatus for detecting impurities in liquid metals by means of changes in electrical resistivity is patented. The invention is particularly applicable to detecting impurities in reactor coolants and includes accurate compensation for changes in temperature. The apparatus consists of a means of comparing a test voltage, dependent upon the current passing through liquid metal in a pipe, with a reference voltage derived from a standard resistance. The standard resistance has one component in thermal contact with the liquid metal and a second component with a resistance substantially independent of temperature. The 2 components are connected by a transformer, and it is possible to vary the proportions of the voltage from each component and thereby vary the overall thermal coefficient of resistivity coefficients of the liquid metal. The temperature-responsive resistance may be a Pt wire noninductively wound around the pipe conducting the liquid metal. (M.P.G.)

Corrosion

Refer also to abstracts 38462, 38463, 38464, 38465, and 38466.

37477 (BMI-1647) RESISTANCE OF CERAMIC FUEL-PARTICLE COATINGS TO REACTIONS WITH OXYGEN AND GRAPHITE. William H. Pfeifer, George W. Cunningham, Donald C. Carmichael, and Edwin S. Hodge (Battelle Memorial Inst., Columbus, Ohio). Sept. 6, 1963. Contract W-7405-eng-92. 22p.

The compatibility of coated particles with various matrix materials and environments was studied using metallographic and x-ray techniques. Al_2O_3-coated UO_2 particles were resistant to oxidation for several thousand hours at temperatures to 1100°C and BeO-coated UO_2 particles to temperatures of 1000°C. In flowing argon, beryllia-graphite mixtures formed the most stable oxide-graphite combination, followed by mixtures of graphite with alumina, magnesia, and zirconia. The results indicated beryllia-graphite mixtures to be compatible for 10000 hr at temperatures >1400°C, alumina-graphite to 1350°C, magnesia-graphite to 950 to 1000°C, and zirconia-graphite to 900 to 1000°C. (auth)

37478 (EUR-379.e) CORROSION STUDIES IN ORGANIC COOLANTS FOR NUCLEAR REACTORS. H. W. Schleicher (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 46p. (CONF-28-6)

From 2nd International Congress on Metallic Corrosion, New York, Mar. 1963.

As part of the ORGEL program, static corrosion tests in organic coolants were carried out. Sintered aluminum powder product of different types, carbon steel, stainless

steel, magnesium, beryllium, and niobium were tested between 400 and 450°C, in autoclaves and pyrex capsules containing a mixture of terphenyls. Exposure times ranged from 24 to 2000 hours. The influence of additions of water, oxygen, and chlorine was studied. Sintered Al, steels, and Be show a good resistance to pure terphenyls, Mg is heavily oxidized, and Nb can be severely hydrided. Water additions accelerate iron corrosion and chlorine enhances the corrosion of both carbon and stainless steels. (auth)

37479 (GEAP-4181) SODIUM MASS TRANSFER: IV. 1962 CORROSION SAMPLE DATA. L. E. Pohl, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 1963. Contract AT(04-3)-189. 158p.

A compilation is presented of Analysis Reports of test runs completed in 1962 on the exposure of ~692 metallic samples to flowing sodium in six test loops. These Analysis Reports contain the loop operating conditions, flow velocities, oxygen levels, and metallographic and chemical analyses. The materials studied include 316 stainless steel, $2\frac{1}{4}$ Cr–1 Mo steel, and 5 Cr–$\frac{1}{2}$ Mo–$\frac{1}{2}$ Ti steel. (D.L.C.)

37480 (HW-76358) CORROSION STUDIES IN SIMULATED N-REACTOR SECONDARY SYSTEM WATER ENVIRONMENT. A. P. Larrick (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1963. Contract AT(45-1)-1350. 29p.

Uniform corrosion and stress-corrosion-cracking tests were made in an out-of-reactor carbon steel pressurized water loop (TF-8) using simulated N-Reactor secondary system water. Materials tested were A212 carbon steel, AISI 304 stainless steel, 70-30 Cupro-Nickel alloy, Admiralty metal, and silicon bronze. Uniform corrosion rates were 0.08, 0.015, 0.05, 0.11, and 0.15 mil/yr, respectively. Stress-corrosion cracking was not observed on any of the alloys. A high initial corrosion of the carbon steel resulted in large amounts of corrosion product crud during the first two weeks of testing; crud levels were sufficiently high to plug the loop filter several times. After a protective oxide formed on the carbon steel surfaces, the corrosion rate and crud release rate were reduced to low values. The much higher blowdown rates attainable in the N-Reactor secondary system are expected to be sufficient to maintain a tolerable crud level during initial startup. The hydrazine levels in the loop varied from 10 to 70 ppb compared to 10 to 20 ppb specified for N-Reactor. The excess hydrazine did not affect the resultant corrosion rates or water quality as verified by a short run where the hydrazine was intentionally maintained at 120 to 250 ppb. Additional testing of stressed AISI 304 stainless steel alternately dried and wetted in an N-Reactor secondary system-type environment failed to produce stress corrosion cracking, even when the water was contaminated with 5% Columbia River water. (auth)

37481 (HW-SA-2954) DENDRITIC PITTING OF STELLITE BY ALKALINE PERMANGANATE SOLUTIONS. R. D. Weed (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Mar. 14, 1963]. Contract AT(45-1)-1350. 15p. (CONF-202-1)

For Presentation at the Electrochemical Society Fall Meeting, New York, Sept. 1963.

Alkaline permanganate solutions cause dendritic pitting in some hard-facing alloys. The magnitude of the pitting observed varied from 2 to 5 mils after 6 two-hour exposure periods in the laboratory tests. Variations in the concentration of either the potassium permanganate or the sodium hydroxide did little to alleviate the pitting corrosion. The pitting attack was not apparent at the lower temperatures; pitting first appeared at 50°C and increased in magnitude as the temperature increased and approaches 105°C, the maximum temperature studied. Chromium and iron were determined as the elements in the selectively dissolved alloyed phase. It was concluded that, if a system is decontaminated repeatedly, the critical valve surfaces such as in drain valves and/or isolation valves must eventually be replaced if a leak tight system is to be maintained. (auth)

37482 (KAPL-M-CC-4) TITANIUM ALLOYS IN 600°F AMMONIATED WATER. C. F. Cheng, S. F. Bubar, and J. J. McCarthy (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 5, 1963. Contract W-31-109-eng-52. 19p.

Three high-strength titanium alloys, (Ti–6Al–4V), (Ti–6Al–6V–2Sn), and (Ti–13V–11Cr–3Al), were corrosion tested in 600°F ammoniated water at pH 10. There was no significant change in mechanical properties before and after exposure in test solution for two alloys, (Ti–6Al–4V) and (Ti–6Al–2Sn). The high vanadium-chromium alloy (Ti–13V–11Cr–3Al) appeared to undergo some reduction in ductility, possibly due to aging. Hydrogen embrittlement due to water corrosion was not detected in any of the three alloys tested. The high vanadium-chromium alloy appeared to have more affinity for hydrogen, particularly during the aerated, ammoniated water exposure period. The combined stress corrosion-crevice corrosion tests with tri-angular bends showed no visible corrosion effects for these three titanium alloys coupled to dissimilar metal tri-angular bends of 17-4 PH stainless steel, Type 304 stainless steel, Type 410 stainless steel, and Inconel Alloy 600. There was no sub-surface corrosion attack when these alloys were immersed in APAC or EDTA decontamination solution. (auth)

37483 (TID-19383) RARE EARTH METALS: CORROSION DATA. Linda Lee and Norbert D. Greene (Rensselaer Polytechnic Inst., Troy, N. Y.). July 1963. Contract AT(30-1)-2714. 15p.

Data on the corrosion characteristics of rare earths are presented in tabular form. Oxidation rates of the rare earths in air were determined in a thermostatically controlled oven. Tests were also conducted in water-saturated air and air in equilibrium with 30% hydrogen peroxide. Corrosion tests were conducted using distilled water and a variety of acids and bases. (M.C.G.)

37484 (TID-19395) CONTRIBUTION TO THE UNDERSTANDING OF HIGH TEMPERATURE OXIDATION. Progress Report No. 2, November 27, 1962–August 16, 1963. J. Bruce Wagner, Jr. (Northwestern Univ., Evanston, Ill. Technological Inst.). Contract AT(11-1)-1126. 9p.

Studies were made on the oxidation of Ti-doped iron in $CO-CO_2$ mixtures at elevated temperatures. A 0.91 wt % Ti alloy appeared to oxidize to wustite containing Ti in solution. Thus, there is a 1:1 correspondence between Ti content and increased vacancy concentration over the normal vacancy concentration in Fe_xO. In addition, the concentration of electron holes is decreased, due to the increase in cation vacancies. This is reflected in a decrease in the electrical conductivity over that of pure Fe_xO. Thermoelectric measurements on Fe_xO were made over the entire phase field from 800 to 1075°C and a p to n transition was found on the oxygen-rich side of the phase field above 900°C. At 1300°C the transition occurs at about the middle of the field. Reduction studies on 0.9 and 0.1 wt % Ti–Fe_2O_3 showed an order of magnitude decrease in the rate of the $Fe_2O_3 \rightarrow Fe_3O_4$ reaction for both. Simultaneously,

the electric conductivity is several orders of magnitude higher than that of pure Fe_2O_3. (P.C.H.)

37485 INVESTIGATION OF THE OXIDATION OF COPPER BY ELECTRON DIFFRACTION. Eiji Yoda and Benjamin M. Siegel (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys., 34: 1512-15(May 1963).

The manner in which the oxide phase nucleates and grows on copper single crystals exposed to oxygen at a pressure of 1×10^{-2} mm of Hg and at temperatures between 300 and 400°C was investigated by reflection electron diffraction and electron microscopy. Widely spaced oxide crystallites oriented with the [110] direction parallel to the [110] direction of the copper form and continue to grow at these temperatures even after the removal of the oxygen atmosphere. No polycrystalline phase was observed to form under these conditions, but the intensities of the copper spot pattern and Kikuchi lines decreased during exposure to oxygen and partially recovers in intensity during subsequent heat treatment. (auth)

37486 OXIDATION OF 90 Cb–10 Ti ALLOY IN THE TEMPERATURE RANGE 500–1200°C. Thaddeus L. Kolski (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). Trans. Am. Soc. Metals, 56: 528-39(Sept. 1963).

Reaction rates of 90 Nb–10 Ti alloy with oxygen at 1 atm were determined gravimetrically at temperatures between 500 and 1200°C, for reaction times ranging from 25 to 200 hr. At 700°C, a high oxidation rate follows a breakaway transition in kinetics after 15 to 20 hr from a rate which originally decreases with time. A mild breakaway transition occurs at 600°C after about 60 hr, but total oxygen absorption is low even after 150 hr. Oxidation rate at 500°C is extremely slow, total uptake of oxygen amounting to only 1.4 mg per cm^2 after 200 hr. Above 700°C a rate inversion occurs with increasing temperature; oxidation rate passes through a minimum near 800°C, then rises with further temperature increase. Analysis and x-ray diffraction patterns of outer scales formed on 90 Nb–10 Ti at 800°C or higher tentatively indicate that these consist of solid solutions of TiO_2 in Nb_2O_5. The outer scale formed at 700°C is not fully oxidized and exhibits a diffraction pattern different from the one characteristic of scales formed at higher temperatures. Little or no loose outer scale is formed at lower temperatures, but the absorbed oxygen forms a hard case of tightly adherent oxide. Oxygen contaminated zones are formed under the outer oxide growth at higher temperatures and attain thicknesses which increase markedly with oxidation temperature. A tentative mechanism for the accelerated oxidation observed near 700°C is proposed; it is based on severe surface cracking of the oxygen-contaminated zone. (auth)

Fabrication

Refer also to abstract 38457.

37487 (AD-295919) DIFFUSION BONDING OF REFRACTORY METALS. Interim Technical Progress Report 2, September 29, 1962 through December 28, 1962. A. G. Metcalfe and T. B. Lindemer (Solar Aircraft Co., San Diego, Calif.). Jan. 2, 1963. Contract AF33(657)-8789 69p. (RDR-1322-2)

Six concepts to actuate the diffusion bonding process were evaluated experimentally. Three of these, surface active elements, recrystallization of cold worked metal, and allotropic transformations, promote bonding. Small atom diffusion aids, acceleration of diffusion by a high frequency field, and bonding under subsolidus conditions are ineffective or inapplicable to refractory metal bonding. The magnitude of improvement of joints with intermediate foils that recrystallize or undergo allotropic transformation was found to be small, whereas surface active elements produce a severalfold increase in bond strength. (auth)

37488 (ANL-6724) DEVELOPMENT AND EVALUATION OF PROTOTYPE REMOTE-CONTROLLED SODIUM-BONDING AND BOND-INSPECTION PROCESSES FOR EBR-II FUEL CYCLE FACILITY. Thomas C. Cameron and Harold M. McCall, Jr. (Argonne National Lab., Ill.). May 1963. Contract W-31-109-eng-38. 33p.

The EBR-II plant includes an integral, remote-controlled Fuel Cycle Facility wherein spent fuel elements are to be pyrometallurgically refined, refabricated, inspected, and reassembled for return to the reactor. A description is given of the experimentally supported changes and refinements made in the prototype sodium-bonding and bond-inspection equipment to ensure: (1) acceptable fuel elements for the initial core loading; and (2) equally acceptable elements in production quantities in the parent installation. More specifically, the mode of imparting bonding energy to the fuel element was changed from a vibratory action to a series of timed impacts. This reflected an increase in the yield of acceptable elements and a reduction of machine operation time. A nondestructive, eddy-current instrument was developed and demonstrated as capable of detecting all defects in the liquid sodium bond. The diameter of the lower restrainer knob in the fuel element was increased to eliminate eccentricity as a contributor to erratic level of the sodium bond. As a result, the sodium level can be detected to a tolerance of $\pm 1/64$ in. with a single, encircling eddy-current coil. Shrinkage voids in the sodium were not encountered. However, laboratory test data are presented in support of the conclusions that: (1) shrinkage voids can be promoted by improper cooling, even in initially void-free elements; and (2) the voids are transient in nature and do not permanently disturb the homogeneity of the sodium bond. (auth)

37489 (GEMP-219) THE SINTERING OF BeO TO VARIABLE DENSITIES AND GRAIN SIZES. E. C. Duderstadt and J. F. White (General Electric Co. Advanced Technology Services, Cincinnati). Sept. 1963. Contract AT(40-1)-2847. 51p.

A description is given of the preparation of BeO samples for study of the effects of irradiation including the influence of purity, additives, porosity, and grain size. These samples were prepared from three commercially available grades of BeO using extrusion and sintering as the main means of fabrication. One grade of BeO contained some long needle-like particles and preferred orientation was observed in extruded samples from this material. The sintering behavior generally followed the normally observed characteristics. Low density material, prepared by adding an organic material, however, showed the predicted behavior expected from the presence of pores about 10 microns in diameter. The BeO powder characteristics are given along with the sintering data and photomicrographs of typical samples. The grain growth versus time at temperature for densities of 2.60, 2.75, and 2.95 gms/cm^3 are shown for grain sizes up to 100 microns. (auth)

37490 (NAA-SR-8108) PLASTIC DEFORMATION OF URANIUM CARBIDE CRYSTALS. G. G. Bentle, F. E. Ekstrom, and R. Chang (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 30, 1963. Contract AT(11-1)-Gen-8. 25p.

The flow behavior of nearly stoichiometric uranium

carbide single crystals in the temperature range of 1500 to 2000°C was studied by compression loading. The mechanism of flow is similar to that previously reported for uranium carbide polycrystals. The slip system for uranium carbide was found to be predominantly (111) [$1\bar{1}0$]. (auth)

37491 (NAA-SR-8263) MAGNETIC PULSE SWAGING OF APM–UO_2 FUEL RODS. E. C. Supan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 30, 1963. Contract AT(11-1)-Gen-8. 21p.

Magnetic pulse swaging, a new high energy rate metalworking process, was investigated as a method for eliminating the fuel-cladding annulus in fuel rods made of UO_2 pellets clad with APM tubing. Three simulated fuel rods were fabricated in which the cladding was swaged through the application of electromagnetic forces. Radiographic inspection of the rods revealed intimate contact between the cladding and the simulated fuel pellets. In one of the fuel rods, containing UO_2 pellets, the contact was maintained after thermal cycling and heat treatment to 900°F. It is believed that tensile hoop stresses are present in the swaged cladding, but the effect of these stresses was not fully investigated. (P.C.H.)

37492 (SCL-B-107) HYDROGEN AND HELIUM PERMEABILITY OF STEEL AND OF NICKEL, COPPER, ALUMINUM, GOLD, PLATINUM AND THEIR ALLOYS. A BIBLIOGRAPHY. Florence Macpherson, comp. (Sandia Corp., Albuquerque, N. Mex.). May 1, 1963. Contract [AT(29-1)-789]. 72p.

References (241) are given to reports and U.S. and foreign journals published from 1947 to 1963. A separate author index is included. (P.C.H.)

37493 (UCRL-6940) SELF-DIFFUSION OF OXYGEN IN SINGLE-CRYSTAL BERYLLIUM OXIDE. J. Birch Holt (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 28, 1962. Contract W-7405-eng-48. 13p.

Self-diffusion of oxygen in beryllium oxide was studied by means of the isotope exchange between gaseous oxygen enriched with O^{18} and crushed single crystals of beryllia. The progress of the diffusion was followed by measuring the decrease in O^{18} concentration in a well stirred gas of constant volume. Measurements were carried out in the range from 1300 to 1700°C. An activation energy for diffusion of approximately 68 kcal/mole was found. Comparison of the diffusion coefficients determined with those from a previous investigation on polycrystalline beryllium oxide indicates a difference of approximately $1\frac{1}{2}$ orders of magnitude. Several explanations for the difference are considered. (auth)

37494 (UCRL-7158) THE DECOMPOSITION PRESSURES OF α- AND β–Nb_3Ge_3 AND THE THERMODYNAMIC STABILITY OF $NbGe_2$. John H. Carpenter and Alan W. Searcy (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 11, 1962. Contract W-7405-eng-48. 13p.

The decomposition pressures of α–Nb_3Ge_3 ($NbGe_{0.54}$) and β–Nb_3Ge_3 ($NbGe_{0.67}$) were measured by the Knudsen effusion method. For the decomposition of α–Nb_3Ge_3 by the reaction, 3.13 $NbGe_{0.54}$ (s) = 3.13 $NbGe_{0.221}$ (s) + Ge(g), $\Delta H^0_{298} = 118.7 \pm 3$ kcal. The apparent decomposition pressure of β–Nb_3Ge_3 was found to vary with effusion orifice area. The mechanism of evaporation is discussed and the equilibrium decomposition pressure of β–Nb_3Ge_3 calculated. For the reaction 7.69 $NbGe_{0.67}$(s) = 7.69 $NbGe_{0.54}$(s) + Ge(g), the equilibrium pressure is $2.44 \pm 0.10 \times 10^{-5}$ atm at 1757°K. Decomposition data for α- and β-Nb_3Ge_3 and $NbGe_2$ give the following enthalpies of formation at 298°K; 1/0.54 $NbGe_{0.54}$, – 27.4 ± 2 kcal; 1/0.67 $NbGe_{0.67}$, – 23.2 ± 2 kcal; 1/2 $NbGe_2$, – 10.5 ± 2 kcal. (auth)

37495 (TRG-Inf-Ser-100) ZIRCONIUM AND ZIRCONIUM ALLOYS FOR WATER COOLED REACTORS. L. Bangert and K. Hennemann. Translated by L. F. Secretan (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Metall, 14: 704-10 (1960). 17p.

The corrosion behavior of zirconium and its alloys was investigated. The alloying effects of Sn, Nb, Cr, and Fe on Zr were tested at 400°C in steam and at a pressure of 300 atm. Small quantities of the alloying elements improved the corrosion resistance considerably, but after the corrosion resistance has passed through a maximum further alloying additions only reduce it. Corrosion tests of Zr alloys were made under various conditions: water, 360°C, 200 atm, pH 7 at 20°C; steam, 360, 400, 500, and 600°C, 1 atm; and steam, 400 to 500°C, about 200 to 300 atm. The effects of pressure, melting process, heat treatment, and melting technique on the corrosion of Zr alloys are also discussed. (P.C.H.)

37496 CARBIDE FUELS WITH HIGH FISSION-PRODUCT RETENTION FOR HIGH-TEMPERATURE REACTORS. H. Bildstein and P. Koss (Osterreichische Studiengesellschaft für Atominergie GmbH, Vienna). Atompraxis, 9: 259-64(July 1963). (In German)

The individual steps for the production of a fuel with high fission-product retention for high-temperature reactors are described. These include the preparation of the carbides and mixed carbides of uranium, thorium, and zirconium, their transformation into coated, spherical particles, and the preparation of graphite-based fuel inserts. A survey on the methods of production control and evaluation is also given. (auth)

37497 DIAMONDS IN ATOMIC ENERGY RESEARCH. I. MACHINING OF SAPPHIRE. L. M. Davies, R. N. Simmonds, and Thorold Jones (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Ind. Diamond Rev., 23: 97-100(Apr. 1963).

The technique for machining synthetic sapphire rods is given. The rod ends are ground first by gripping the rod in a pin vice, lead foil lined and mounted in the machine workhead. The rod is then rotated at 56 rev/min and the table on which the workhead is mounted is traversed at 1 ft/min across a peripheral wheel (metal bonded, diamond grit grade 260-300, 8 in. dia, $\frac{3}{8}$ in. wide, $\frac{3}{32}$ in. radius on edges) rotating at 2300 rev/min that is, a peripheral speed of 4770 ft/min. The rod ends are ground to 0.15 in. dia. The central part of the rod is then ground in much the same way as the ends. The rods are then polished by the borax method. (P.C.H.)

37498 DIAMONDS IN ATOMIC ENERGY RESEARCH. II. DIAMOND GRINDING OF MAGNESIUM OXIDE. R. N. Simmonds, R. A. J. Sambell, and A. Briggs (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Ind. Diamond Rev., 23: 126-7(May 1963).

A block of as-received crystal is cleft to give rectangular slabs having the same length, and a thickness of the same width as the required specimens. After accurate measurement a slab is set up on a mounting, aligned, and fixed in plate with Picien wax. A diamond wheel, made to specifications, is located above the crystal by means of gauge blocks and feelers. The special wheel is round faced, metal bonded, 4 in. in dia, and $\frac{3}{8}$ in. thick, with an accurate $\frac{3}{16}$ in. radius on the periphery. It contains diamond grade 260-300 and revolves at 2300 rev/min.

When one side of the reduced section is finished, the slab is then inverted, and the operation repeated to give an identical reduction on the opposite side. Total grinding time is 9 hr. (P.C.H.)

37499 PREFERRED ORIENTATION IN CERAMIC MATERIALS DUE TO FORMING TECHNIQUES. Joseph L. Pentecost and Charles H. Wright (Melpar, Inc., Falls Church, Va.). 20p. (CONF-174-1)

From 12th Annual Conference Application of X-ray Analysis, Denver, Aug. 1963.

Studies were made on the magnitude of the preferred orientation in common ceramics and pole figures by which the orientation could be described were constructed. Special attention was given to Al_2O_3 and BeO. Some degree of preferred orientation was noted in most specimens examined, however it was most pronounced in Al_2O_3 that was slip cast and in dry-pressed BeO. The pole figures plotted from the data are not symmetrical, but it is believed that they probably represent local variations, or the contributions of local biaxial flow during forming. For the slip-cast Al_2O_3, the preferred orientation was most pronounced. The platelets, which were essentially (001) planes, tended to orient parallel to the mold face. Dry-pressed Al_2O_3 exhibited orientation similar to slip-cast specimens, but not as pronounced. Dry-pressed BeO exhibited orientation of the crystallites with the C axis perpendicular to applied pressure. (P.C.H.)

37500 IMPROVEMENTS IN PROCESS FOR PRODUCING HIGH DENSITY REFRACTORY BODIES. (to General Electric Co.). British Patent 933,824. Aug. 14, 1963. Priority date Jan. 20, 1959, United States.

A process for the production of high-density bodies from refractory metals, such as W, Nb, Mo, and Ta, and refractory compounds of U, Pu, and Th is patented. The powdered high-melting-point material is blended with a finely powdered lubricant-binder of paraffin wax to form a free-flowing mixture. The mixture is formed into an unsintered solid body and presintered at a relatively low temperature to remove the lubricant-binder. The body is then sintered at a relatively high temperature below the melting point to shrink the body and produce a solid material having a density of 94 to 100% of the theoretical maximum. (M.P.G.)

37501 PRODUCTION OF HIGH DENSITY SINTERED URANIUM OXIDE. Harold Rawson and Charles Anthony Elyard (to Associated Electrical Industries Ltd.). British Patent 934,254. Aug. 14, 1963. Filed July 15, 1959.

A process for obtaining a sintered UO_2 ceramic of high density for use as a reactor fuel is patented. The process consists of compacting a mixture of powdered oxide of U in the composition range $UO_{2.1}$ to $UO_{2.25}$ with up to 0.1% by weight of Pt uniformly dispersed over the surface of the oxide particles. The compacted mixture is sintered at a temperature of 1400°C. The Pt is dispersed over the surface of the oxide particles by mixing the UO_2 with a water solution of a Pt salt and heating the mixture in an inert atmosphere to decompose the salt. The sintered compacted body may be heated in H to a temperature of 1200°C to reduce the oxide to UO_2 of stoichiometric ratio. (M.P.G.)

37502 THE MANUFACTURE OF EXTERNALLY-FINNED TUBING. Edgar William Dalby (Fairey Engineering Ltd). British Patent 936,166. Sept. 4, 1963. Filed May 4, 1961.

A method of making an externally finned metal tube for heat exchangers or reactor fuel cans is patented. The method is particularly applicable to the manufacture of herring-bone fin patterns on cylindrical tubing, in which oppositely inclined sets of oblique fins are formed on adjacent parts of the surface of the tube. An elongated straight tubular workpiece is formed with a number of longitudinal flat sides separated by longitudinal groves in the outer surface. By conventional machining operations, sets of parallel fins are machined on each flat side. The workpiece is then expanded to deform the flat sides until the tube has an overall cylindrical form, from which the fins project. The expanding operation is performed by forcing a plug of circular section through the bore of the workpiece. (M.P.G.)

Properties and Structure

Refer also to abstracts 37687, 37688, 37693, 37694, 37695, 37696, 37700, 37703, 37704, 37706, 37707, 37709, 37712, 37713, 37714, 37715, 37716, 37717, 37770, 37771, 37774, 37775, 37777, 37779, 37781, 37795, 37799, 37802, 37815, 37817, 37818, 37819, 37820, 37821, 37822, 37824, 37825, 37826, 37828, 38031, 38033, 38034, 38046, and 38048.

37503 (AD-290693) FINAL TECHNICAL REPORT [ON REFRACTORY OXIDES]. Karl S. Vorres (Miami, Fla. Univ., Coral Gables). Nov. 1962. 34p.

The conditions for the appearance of the fluorite-type solid solution with ZrO_2 were investigated experimentally by studying sub-solidus equilibria in the binary systems composed of ZrO_2 and each of CuO, Cu_2O, SnO_2, Ag_2O, Tl_2O, CdO, and Ga_2O_3. No solid-solution formation was observed. The data were correlated with all other data on binary systems with ZrO_2 to determine conditions for the appearance of the fluorite phase. A plot of ionic radius versus electronegativity most effectively demonstrated that the conditions are: the added oxide must have a cation radius larger than that of tetravalent Zr to be stable down to room temperature, and the added oxide must be somewhat more electropositive than the Zr. This then produces a more nearly ionic lattice for which the fluorite structure would be expected. Furthermore, the added oxide must be di- or trivalent. Random cation placement occurs with divalent cations and ordering is obtained with the trivalent ones. The CaF_2-rare earth oxide systems in a laboratory atmosphere were studied, and ABO_4 type structures were correlated. (auth)

37504 (ASD-TDR-62-225) THE ROLE OF THE GRAIN BOUNDARY IN THE DEFORMATION OF CERAMIC MATERIALS. G. T. Murray, J. Silgailis, and A. J. Mountvala (Materials Research Corp., Orangeburg, N. Y.). Jan. 1962. Contract AF33(616)-7961. 34p. (AD-295551)

The grain boundaries of MgO bicrystal specimens were subjected to creep-rupture tests in the temperature range of 1300 to 1500°C and at shear stresses varying from 150 to 10,000 gm/sq. mm. The boundary was oriented at 45° to the compression direction. The stress for grain boundary sliding and fracture varied markedly with crystal misorientation; high twist-low tilt boundaries were much weaker than other misorientations. For a given misorientation there was considerable scatter in the fracture and sliding stress data which was found to be a result of boundary irregularities (jog content) present in the as-received material or stress-induced during test. Most specimens did not exhibit controlled grain boundary sliding but, rather, would slide uncontrollably to fracture after an incubation period of a few minutes at a critical stress. (auth)

37505 (ASD-TDR-63-605(Pt.I)) A STUDY OF THE PHYSICAL BASIS OF THE MECHANICAL PROPERTIES OF CERAMICS. Gordon E. Gross (Midwest Research Inst., Kansas City, Mo.). June 1963. Contract AF33(657)-8572. 30p. (AD-416036)

A literature survey of the properties of ceramics, both classical and more recent solid theory, is presented. A better understanding of the ceramic properties as related to their electron-lattice structure was gained by correlating the mechanical properties of brittleness and ductility with the electronic and crystalline (lattice) properties of materials. To achieve the above, three goals were set: (1) To establish a physical basis for the brittleness and ductility of insulators (e.g., ceramics) and semi-metallic materials; (2) To develop an understanding of the role of surface energy in fracture of ceramics and other nonmetals; and (3) To reach some practical conclusions regarding the scatter in test values for strength of ceramic specimens. Experimental methods and results are given for surface energy and Hall coefficients measurements. (auth)

37506 (BLR-62-26) TENSILE AND CREEP PROPERTIES OF COLUMBIUM, TANTALUM, AND TITANIUM ALLOYS AT ELEVATED TEMPERATURES. P. E. Moorhead (Bell Aerosystems Co., Buffalo). Dec. 10, 1962. Contract AF33(657)-8555. 51p. (AD-296198)

Tensile and creep tests were conducted on niobium alloys B-33, Cb-752, SCb-291; tantalum alloy Ta–10W; and titanium alloy Ti–13Cr–11V–3Al at elevated temperatures. The niobium alloys and Ta–10W were tested at 2800, 3100, and 3400°F. The titanium alloy was tested at 1800, 2050, and 2300°F. (auth)

37507 (BMI-X-257) PROGRESS ON USAEC/AECL COOPERATIVE PROGRAM. Quarterly Report, June 1963–August 1963. Stanley W. Porembka (Battelle Memorial Inst., Columbus, Ohio). Sept. 18, 1963. Contract W-7405-eng-92. 17p.

Progress at Battelle on studies relating to the U. S. and Canadian programs on heavy-water-moderated and organic-cooled reactors is described. Present research efforts involve the determination of long-term creep-rupture properties on selected SAP alloys and Zircaloy-2. The Zircaloy-2 tests in this program represent a continuation of tests initiated under Hanford sponsorship and are of particular interest since accumulated test times approximate up to 6 years. Tests were continued on both types of specimens. Short-term tests were initiated on a SAP-915 alloy which was selected as a replacement for the M-583 alloy. Several long-term tests on the remaining two SAP alloys were concluded. All Zircaloy tests have continued with the annealed specimens exhibiting primary-stage creep behavior and the cold-worked materials a third-stage behavior. (auth)

37508 (GA-4495) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report for the Period Ending June 30, 1963. T. A. Trozera, R. H. Chambers, D. F. Stoneburner, and J. L. White (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Aug. 30, 1963. Contract AT(04-3)-167. 21p.

Deformation Mechanisms in BCC Metals. Thin-film microscopic observations are presented for rolled single TA crystals. These observations show numerous areas almost devoid of slip markings. One specimen was annealed in air at 400°C to pin all the dislocations; transmission micrography of the annealed specimen indicates a quite low temperature for dislocation rearrangements. A correlation was found between the temperatures of the stages in the amplitude-dependent modulus defect and the deformation-peak temperatures for Nb. It is concluded that much more extensive dislocation motion is possible for a given applied stress amplitude at temperatures above the α peak than below, and that limited dislocation motion is possible at very low temperatures if the applied stress is great enough. Stored-Energy Release in Deformed Metals. Stored-energy-release measurements were made on Puron and Ferrovac E grades of pure Fe for several grain sizes and strain levels. The results indicate that the stored energies and dislocation densities in Fe are much smaller than in Cu and other metals. (D.L.C.)

37509 (HW-78132) SURFACE TENSION STUDIES ON URANIUM AND COPPER. J. H. Hoage (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 22, 1963. Contract AT(45-1)-1350. 19p.

A determination of the value of surface tension of uranium was attempted by measuring the longitudinal strain in fine wires (0.00315-inch-diameter) as a function of load at elevated temperature. The work with uranium was unsuccessful because: (1) the uranium oxidized in a vacuum system at 10^{-6} mm Hg pressure, contaminating the surface and forming uranium oxide; (2) the complex crystallographic nature of uranium did not permit the formation of the structure necessary for surface tension determination; (3) the temperature of the experiment, 600°C, although in the high alpha range, was too far below the melting point of uranium to permit viscous flow within a reasonable time. A value for the surface tension of high purity copper at 900°C was successfully obtained utilizing a modification of the uranium measurement attempt. High purity copper wires (0.00315-inch-diameter) were gage marked with knots at intervals of about ½ inch. The wires were held at 900°C for 500 hours. By plotting the elongation or contraction of the gage lengths versus the load at the midgage point, the load required to just balance the contractile stress of surface tension was obtained. The surface tension value (γ) obtained for 0.00315-inch-diameter copper wire at 900°C was $\gamma = 1755 \pm 89$ dynes/cm. (auth)

37510 (IGR-TM/C-0164) THERMAL CONDUCTIVITY OF URANIUM MONOCARBIDE. V. C. Howard (United Kingdom Atomic Energy Authority. Industrial Group. Culcheth Labs., Lancs, England). May 1958. 5p.

The thermal conductivity of UC with a density of ~10.5 g/cc was measured at 60°C and found to be 0.031 ±0.003 cal/cm-sec-°C. From this result, the thermal conductivity of UC with theoretical density (13.6 g/cc) is estimated to be 0.041 ± 0.004 cal/cm-sec-°C, well below that of U metal. The previously published higher values for UC are examined and concluded to be erroneous. (D.L.C.)

37511 (IS-474) THE URANIUM–RHENIUM ALLOY SYSTEM. R. J. Jackson, D. E. Williams, and W. L. Larsen (Ames Lab., Ames, Iowa). [Jan. 14, 1963]. Contract [W-7405-eng-82]. 32p.

The phase diagram of the uranium–rhenium alloy system is presented along with a discussion on transformation kinetics of the uranium solid solutions. The phase diagram is of the double eutectic type with the intermediate phase having the composition URe_2. This phase exhibits allotropy at 180°C and melts congruently at 2200°C. URe_2 reacts sluggishly with the uranium solid solutions below 750°C to form the peritectoid compound U_2Re. Eutectic reactions occur at 1105 and 2105°C at respective compositions of 10.5 and 65.5 wt.% Re. Eutectoid reactions occur at 643 and 681°C at compositions of 1.4 and 6 wt.% Re, respec-

tively. The maximum solubility of rhenium in α uranium is about 0.4 wt.% at 643°C and in β uranium is 1.9 wt.% at 681°C. The solubility of rhenium in γ uranium is 6 wt.% at 681°C and increases to about 7 wt.% at 975°C. The solubility of uranium is rhenium is 0.6 wt.% at room temperature with little variation up to 2000°C. Alloys of β and γ uranium containing more than about 1.2 and 7 wt.% Re, respectively, can be readily supercooled to room temperature. Rapid cooling of γ alloys containing less than about 7 wt.% Re resulted in a direct $\gamma \rightarrow \alpha'$ transformation, the α' state being a supersaturated α phase having a banded microstructure. Evidence is presented for the existence of two transition states, one involving the γ phase decomposition and the other the $\beta \rightarrow \alpha$ transformation. Also, the sequence of phase changes involved in cooling the uranium solid solutions is discussed. (auth)

37512 (KAPL-M-JJI-1) FEASIBILITY OF HARD SURFACING AGE HARDENABLE Ni–Cr–Fe ALLOY. J. J. Inouye and F. D. Lordi (Knolls Atomic Power Lab., Schenectady, N. Y.). May 21, 1963. Contract W-31-109-eng-52. 18p.

Four $^{5}/_{16}$ in. thick mockups from different heats of age hardenable Ni–Cr–Fe alloy material were overlayed with Stellite-6 using the inert gas tungsten arc process. Each hard surfaced mockup was subjected to dye penetrant and metallographic examination. Good bonding and material compatibility was observed in all mockups. Defects observed in the overlay of two of the metallographic sections were attributable to improper welder technique. Difficulty in obtaining a hardness of Rc 37 at $^{1}/_{16}$ in. overlay thickness was encountered. Preliminary tests indicate that higher hardness of Rc 40 or greater could be achieved without difficulty by refinement of welding techniques. The results indicate the process to be feasible and reproducible for the section size studied. (auth)

37513 (NMI-2810) PROGRESS ON THE STUDY OF THE URANIUM–ALUMINUM–IRON CONSTITUTION DIAGRAM FOR THE PERIOD APRIL 1–AUGUST 31, 1963. R. B. Russell (Nuclear Metals, Inc., West Concord, Mass.). Sept. 18, 1963. Contract AT(40-1)-3022. 47p.

Progress is reported of a research program on determining the U–Al–Fe constitution diagram up to ~1000 ppm each of Al and Fe. Results are reported of metallographic examinations of U–Al, U–Fe, and U–Al–Fe alloys, and tentative phase diagrams are given for all three systems. Lattice parameters and electrical resistances were measured in an effort to determine the solid solubilities of Al and Fe in U. (D.L.C.)

37514 (NP-13054) ORIENTATION OF URANIUM AFTER A β-α TRANSFORMATION. W. S. Blackburn (International Research & Development Co. Ltd., Newcastle-upon-Tyne, England). 1962. Contract CON/HAR/EMR/1519. 15p.

Lomer derived four sets of eight strains of less than 20% which, when applied to the beta phase of a uranium 1.4% chromium alloy, transforms one or two atoms out of every sixty into the appropriate position of the alpha phase. The relative orientations of the crystal axes of the two phases in a stress and strain free system were deduced, and three of these sets of relationships were observed experimentally by Butcher and Rowe. If some of the beta phase near the transition temperature undergoes a strain similar to one of those in the three sets deduced by Lomer whose members were observed, it is more liable to nucleate the alpha phase and to take up an orientation in which the directions of the crystal axes are related to those of the parent beta phase in the manner determined by Lomer. One of each of these sets is such that the a, b, and c crystal axes of the beta phase are given in terms of those of the alpha phase by I $(-\frac{1}{2}, -\frac{3}{2}, 1)$, $(\frac{7}{2}, -\frac{1}{2}, 0)$, $(\frac{1}{2}, \frac{1}{2}, 1)$; II $(\frac{3}{2}, -\frac{3}{2}, 1)$, $(-\frac{13}{4}, -\frac{1}{4}, \frac{1}{2})$, $(\frac{1}{2}, \frac{1}{2}, 0)$; and III $(\frac{11}{4}, \frac{3}{4}, -\frac{1}{2})$, $(-\frac{1}{2}, -\frac{1}{2}, 2)$, (1, –1, 0). The other transformations of each set are obtained from these by changing the signs of the a and/or b components and by interchanging them. The corresponding strains were deduced for pure uranium, and that strain in each set which is nearest to a uniaxial tensile or compressive strain in various directions was determined. Transformations of set I and to a lesser extent set II tend to align a axes in the direction of, and b axes perpendicular to, the direction of compression, while those of set III counteract this tendency. Transformations of set III tend to align a axes along a direction of uniaxial tensile stress while those of sets I and II tend to align them at an angle to this direction. Those of set I tend to align b axes at an angle also while those of sets II and III tend to align them perpendicular to the stress. Transformations of sets I and II tend to align b axes tangential to a free surface and a axes at an angle to it while those of set III tend to align a axes both normal and tangential to it. If all sets are equally likely to occur there would be an excess of b axes perpendicular to, and a deficiency of b axes parallel to a direction of uniaxial compressive or tensile stress or to a normal to a free surface and a deficiency of a axes perpendicular to a direction of uniaxial tensile stress. (auth)

37515 (SWRI-5-1276-7-2) NONDESTRUCTIVE TESTING OF PLASTIC FATIGUE PRESSURE VESSELS. Topical Report No. 2. Period Covered: March 31, 1963–August 31, 1963. Clarence E. Lautzenheiser and Allen R. Whiting (Southwest Research Inst., San Antonio). Sept. 6, 1963. Contract AT(11-1)-1228. 99p.

A research program is being conducted to improve the knowledge and nondestructive testing methods of crack initiation and propagation rate in pressure vessels subjected to low-cycle plastic fatigue. Emphasis is on ultrasonic methods, although radiography and other methods will also be tested. The results obtained so far indicate that the defect propagation rates are not linear with time and that no appreciable growth occurs until a critical number of fatigue cycles is reached. This number is dependent on the strain in the defect location and other variables. (D.L.C.)

37516 (TID-17624) THE SYSTEM UAl_2–UFe_2. D. J. Lam, J. B. Darby, Jr., L. J. Norton, and J. W. Downey (Argonne National Lab., Ill.). Oct. 12, 1962. Contract [W-31-109-eng-38]. 8p. (ANL-FGF-398; UAC-6976)

The vertical section between UAl_2 and UFe_2 in the U–Al–Fe ternary system was investigated using conventional techniques. The two component phases are found to have a relatively wide range of terminal solid solubility and are separated by two unidentified ternary compounds having a complex structure. (auth)

37517 (TID-19382) THE STRUCTURE OF MOLTEN TIN. Technical Report No. 1. M. L. Joshi (Yale Univ., New Haven. Hammond Metallurgical Lab.). June 1963. Contract AT(30-1)-2560. 29p.

The x-ray diffraction patterns of liquid Sn at 238 and 390°C were measured using molybdenum radiation, monochromatized by balanced filters. The high-temperature high-vacuum x-ray diffractometer attachment was altered for this purpose and was able to reach about 1400°C in a liquid sample of size 1 in. × 1 in. in vacuum. The atomic distributions in liquid Sn at these temperatures were ob-

tained by Fourier analysis of si(s) curves with the help of a Mader-Ott harmonic analyzer. The spurious details in radial distribution curve due to replacement of the limit $s_{max} = \infty$ by the experimental finite upper limit of $s_{max} = 15\ A^{-1}$ could be reduced considerably by modifying the si(s) curves by e^{-as^2}. The preferred interatomic distances were not significantly sensitive to the temperature of the melt. The first three preferred interatomic distances $r_1 = 3.17$, $r_2 = 6.35$, and $r_3 = 9.5$ Å were found to be in the ratio of 1:2:3. A small peak in the range r = 4.3 to r = 4.5 Å existed and seemed to correspond to the 8 neighbours at 4.4 Å in solid Sn. (auth)

37518 (UCRL-7157) THE COMPOSITION RANGE, DECOMPOSITION PRESSURE, AND THERMODYNAMIC STABILITY OF Nb_3Ge. John H. Carpenter (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 11, 1962. Contract W-7405-eng-48. 16p.

The phase of ideal composition Nb_2Ge was found to have a solid solution range extending from $NbGe_{0.221 \pm 0.006}$ to $NbGe_{0.159 \pm 0.006}$ at 1600° as determined from x-ray diffraction lattice parameter studies. The decomposition pressure of germanium over Nb_3Ge was determined by the Knudsen effusion method. Surface depletion of the vapor pressure sample was encountered, but equilibrium decomposition pressures were derived from the data. The enthalpy of the decomposition reaction, $6.29\ NbGe_{0.159}(s) = 6.29\ Nb(s) + Ge(g)$, is 123.7 ± 3 kcal. (auth)

37519 (AEC-tr-5983) STUDY OF THE SATURATED VAPOR PRESSURE OF LIQUID METALS AND THEIR IMPURITIES BY THE CARRIER GAS METHOD. V. T. Burtsev and A. M. Samarin. Translated for Ames Lab., Ames, Iowa from Zavodsk. Lab., 28: 1199-1203(1962). 8p.

The factors affecting the accuracy of the vapor pressure determinations of liquid metals were investigated. The saturated vapor pressure of silver at 1150 and 1250°C was measured. The limit of error of the method was found to be 7%. The vapor pressure of pure iron was studied, and the divergence between the experimental data and the values reported in the literature amounted to 3.5%. The partial pressure of the saturated sulfur vapor over iron–sulfur melts containing 0.067 to 0.57% sulfur was determined at 1580 and 1680°C. (auth)

37520 (TRG-Inf-Ser-88) CONSIDERATION AT THE DESIGN STAGE OF BRITTLE FRACTURES IN WELDED STRUCTURES. Y. Akita. Translated by S. G. Brickley (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Nippon Kikai Gakkai-shi, 63: 1632-40(1960). 17p.

A treatment is presented of the factors involving brittle fractures which must be considered in selecting steel materials. Experiments on the propagation of brittle cracks are reviewed, and the different tests are discussed. The effects of plate thickness on brittleness and the correlation of small-scale and large-scale tests are considered. Standards for selecting materials on the basis of small-scale tests are outlined. The chemical composition and mechanical properties of various high-strength steels are tabulated. The weldability of steels and brittle fracture tests on welded structures are considered. Stress relief by annealing and by preloading is discussed. Finally, methods of deciding on permissible stress and of determining welded joint efficiency are discussed briefly. (D.L.C.)

37521 (TRG-Inf-Ser-191) CAUSES OF FAILURE OF STEAM SUPERHEATER PIPES MADE FROM 18Cr/12Ni/1Ti STEEL. A. V. Stanyukovich and E. E. Levin. Translated by Z. Januszewski (U.K.A.E.A. Reactor Group, Risley, Lancs, Eng.), from Energomashinostroenie, No. 10, 27-30(1961). 9p.

A study was made of the embrittlement failure of 18Cr/12Ni/Ti steel with intergranular cracks in power stations at high steam temperatures. It was found that the failure is largely due to the bend sections becoming cold-worked during bending, and that scratches on the brittle cold-worked material make it even less ductile. The relationship between the ductility of the material and its state (cold-worked or annealed) is discussed. It is concluded that superheater coils and other pipe elements made from 18Cr/12Ni/Ti steel can be used successfully if the bends are thermally treated in the proper manner, mechanical damage is avoided, and the pipe elements are allowed to expand freely during boiler operation. (D.L.C.)

37522 THE EFFECT OF THE ELECTRON CORRELATION ON THE ELECTRICAL RESISTIVITY OF LIQUID METALS. Hirohisa Endo and Shota Suekane (National Research Council of Canada, Ottawa). Can. J. Phys., 41: 1397-1404(Sept. 1963). (NRC-7464)

An elementary theory of the electrical resistivity of monovalent liquid metals is given. Using the theory of the plasma oscillations of conduction electrons, the electron-ion interactions are separated into two parts: one gives the effective electron-ion interactions, which are screened as the result of the effects of the plasma oscillations of the conduction electrons and contributes directly to the electrical resistivity; the other describes the interactions between the ions and the plasma oscillations. The screened electron-ion interaction is defined as the pseudo-potential of the ion. The theory constructed on the basis of the free-electron model is applied in the first instance to estimate the electrical resistivity of liquid sodium near the melting point. Callaway's potential and the correlation function of ions determined from neutron diffraction experiments are used and the mean free path of a conduction electron is calculated numerically. Therefore, in this theory, the "plasma term" and the "structure term" are not treated separately. (auth)

37523 NbZr SUPERCONDUCTING CRITICAL CURRENT DEPENDENCE ON dI/dt. L. Lesensky and P. W. Neurath (AVCO Corp., Wilmington, Mass.). J. Appl. Phys., 34: 710-11(Mar. 1963).

The dependence of the critical current on its rate of rise is measured for a Nb–25% Zr wire sample in zero applied magnetic field. The critical current density was found to vary from 3.9 to 3.4×10^5 amp/cm^2 between 20 and 100,000 amp/sec, respectively. (R.E.U.)

37524 INTERPRETATION OF THE NEUTRON OR X-RAY SCATTERING FROM A LIQUID-LIKE BINARY. D. T. Keating (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys., 34: 923-5(Apr. 1963).

In the general liquid-like binary three radial densities relating to A–A, B–B, and A–B pairs are needed to characterize the scattering. The three densities can be obtained by the Fourier inversion of the weighted combination of three diffraction patterns, each of which differs by the alteration of the scattering of one or both components. If the density of atoms regardless of type is the same around both components, then only two functions, one this distribution, and the other involving the order between A–B pairs is needed to characterize the scattering. This case is the liquid analog of the crystalline alloy with short-range order. These two functions can be obtained by the

Fourier inversion of a weighted combination of two patterns differing by the alteration of the scattering of the components. (auth)

37525 PULSE METHOD OF MEASURING THERMAL DIFFUSIVITY AT HIGH TEMPERATURES. Robert D. Cowan (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 34: 926-7(Apr. 1963).

Equations are derived giving the temperature distribution within a thin slab of material that received a short pulse of energy on one surface, for the case in which energy loss at the surfaces (by radiation or convection) is not negligible. An analysis of these equations indicates that measurement of thermal diffusivity by the pulse method should be feasible even when losses are so large that the maximum temperature of the far face is only 10 or 20% of the no-loss value; this includes nearly all materials, and temperatures to 2500°K or higher. (auth)

37526 DYNAMICAL BEHAVIOR OF DISLOCATIONS IN THE PRIMARY SLIP SYSTEMS OF BODY-CENTERED CUBIC CRYSTALS. L. J. Teutonico (Republic Aviation Corp., Farmingdale, N. Y.). J. Appl. Phys., 34: 950-5 (Apr. 1963).

The general analysis of uniformly moving dislocations in anisotropic media is applied to investigate the dynamical behavior of dislocations in the primary slip systems of body-centered cubic crystals. Both edge and screw dislocations on the {110}, {112}, and {123} slip planes are considered; in each case, the Burgers vector of the dislocation lies along a (111) direction. Numerical solutions are obtained for the force exerted by a uniformly moving dislocation of similar type on the same slip plane. The b-c-c elements treated are niobium, molybdenum, vanadium, tungsten, tantalum, iron, potassium, sodium, and lithium. Calculated values of the limiting velocities both of edge and screw dislocations are presented, as well as the threshold velocities for the interaction of two edge or two screw dislocations. These calculations determine, for each slip system in each of the elements listed, the extent of the velocity range of anomalous behavior in which two like dislocations attract rather than repel each other. (auth)

37527 A POLARIZED-NEUTRON INVESTIGATION OF THE $MnNi_3$ ALLOY. A. Paoletti and F. P. Ricci (Centro di Studi Nucleari della Casaccia, Rome). J. Appl. Phys., 34: 1571-2(May 1963).

Polarized neutrons were used to determine the magnetic moments of the $MnNi_3$ alloy. The ratio of the magnetic to the nuclear scattering amplitude was determined from the polarization ratio for a given reflection. The magnetic moments of Mn and Ni were calculated by using the magnetic form factors of metallic Ni and the Mn^{2+} ion. The average magnetic moment per atom was found to be $\approx 1\mu_B$, in agreement with experimental results. (C.E.S.)

37528 ELASTIC CONSTANTS OF UC. L. J. Graham, H. Nadler, and R. Chang (Atomics International, Canoga Park, Calif.). J. Appl. Phys., 34: 1572-3(May 1963).

The adiabatic elastic constants of uranium monocarbide single crystals were investigated. Pulsed longitudinal and transverse elastic waves were produced in the specimen at 27 Mc. The elastic constants at 300°K and the approximate linear temperature coefficients of the elastic constants in the temperature range of 150 to 300°K were presented. (C.E.S.)

37529 PARAMAGNETISM AND LATTICE SPACINGS OF SOME CERIUM-RICH CERIUM–EUROPIUM ALLOYS. Sigurds Arajs, Henry Chessin, R. V. Colvin, and G. R. Dubmyre (United States Steel Corp. Research Center, Monroeville, Penna.). J. Appl. Phys., 34: 1668-72(June 1963).

Paramagnetic susceptibility of cerium-rich cerium–europium alloys was studied from 300 to 1050°K. These measurements indicate that the electronic structure of the localized 4f-electrons of europium atoms in solid solution with cerium is very much the same as in europium metal. This finding is supported by the lattice parameter measurements on these alloys at 298°K. The solubility limit of europium in cerium is found to be at 4.6 at. % europium at about 800°K. (auth)

37530 A MODEL FOR BOUNDARY DIFFUSION CONTROLLED CREEP IN POLYCRYSTALLINE MATERIALS. R. L. Coble (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 34: 1679-82(June 1963).

The creep rate ($\dot{e}$) predicted by the boundary diffusion (D_b) model is $\dot{e} \simeq 150\ \sigma\ D_b W\Omega/(GS)^3 kT$, where σ is the stress, W is the boundary width, (GS) is the average grain size, and Ω is vacancy volume. The stress dependence is the same as the lattice diffusion model, given by C. Herring, while the grain size dependence and the numerical constant are greater for boundary diffusion. Discussion of the mechanism of creep in polycrystalline alumina is based on the differences between the lattice and boundary diffusion models. (auth)

37531 INTERDIFFUSION OF GASES IN A LOW-PERMEABILITY GRAPHITE. II. INFLUENCE OF PRESSURE GRADIENTS. R. B. Evans, III, G. M. Watson, and J. Truitt (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 34: 2020-6(July 1963).

A previous experimental investigation of the interdiffusion behavior of two unlike gases within a porous medium at uniform pressure was extended. The extended studies were focused on interdiffusion under the influence of pressure gradients that in turn, give rise to both viscous and diffusive components of the experimentally determined fluxes. The fact that the diffusion processes investigated occurred within the region bounded by the normal and Knudsen regimes, constituted one of the most important features of these studies. The experimentally observed flux phenomena could be readily explained within the framework of a dust-gas model. The flux equations exhibited only one major weakness and this involved the absence of viscous flow contributions resulting from the pressure gradients. However, it was possible to use these and related equations and, with associated parameters, to reconstruct the experimental curves via computations. It was found that the range of applicability of the equations was limited and that none of the parameters could be predicted beforehand. This was partially the result of the internal-pore geometry of the graphite. Nevertheless, the applicability of the existing dust-gas equations to nonuniform pressure conditions was established for the transition region insofar as is possible with a medium such as graphite. (auth)

37532 THERMIONIC PROPERTIES OF SOME REFRACTORY METAL CARBIDES. J. H. Ingold (General Electric Co., Pleasanton, Calif.). J. Appl. Phys., 34: 2033-9(July 1963).

The low-field thermionic emission properties of vacuum hot-pressed samples of MoC, $Ta_{0.8}Zr_{0.2}C$, TiC, HfC, TaC, and ZrC in polycrystalline bulk form were measured over the temperature range 1300 to 1900°K. The samples were well characterized by metallographic examinations and x-ray diffraction analyses. A correlation between microstructure and thermionic emission was observed. The MoC sample was found to be the most copious electron emitter, while the ZrC sample, which was carbon deficient, had the smallest electron emission over the temperature range investigated. (auth)

37533 EQUATION OF STATE OF 6061-T6 ALUMINUM AT LOW PRESSURES. C. D. Lundergan (Sandia Corp., Albuquerque, N. Mex.) and Walter Herrmann. J. Appl. Phys., 34: 2046-52(July 1963).

The Hugoniot equation of state of 6061-T6 aluminum was determined in the pressure range from 0 to 31 kbars from measurements of velocities of plane waves induced by plate impact. Below the Hugoniot yield point of 6.4 ± 0.7 kbars, only an elastic wave was observed, while above both elastic and plastic waves were observed. The measured wave velocities corresponded closely to values predicted from elastic parameters for the material determined in static tests. Above the elastic limit, the free-surface velocity was less than the interface velocity by an amount slightly greater than predicted by theory, and appeared to be a function of target thickness. The measured Hugoniot was found to correspond well with elementary elastic-plastic theory, in which the yield stress is assumed to be a constant, and the change in compressibility with compression is predicted by second order elastic theory. It was found that the measured Hugoniot yield stress corresponded to the static yield stress obtained in simple tension tests, and that the Hugoniot joined smoothly onto an extrapolation of the high pressure Hugoniot data of Walsh and Al'Tshuler. (auth)

37534 ELECTRODELESS DETERMINATION OF ELECTRICAL CONDUCTIVITIES OF MELTS AT ELEVATED TEMPERATURES. S. J. Yosim, L. F. Grantham, E. B. Luchsinger, and R. Wike (Atomics International, Canoga Park, Calif.). Rev. Sci. Instr., 34: 994-6(Sept. 1963).

An electrodeless method for measuring the electrical conductivities of metallic and semiconductor melts at elevated temperatures is described. The transformer "eddy current" method, which was capable of measuring conductivities from one to greater than 10,000 $(\Omega\text{-cm})^{-1}$, was used. The system was calibrated with Hg at 25°C and tested with Hg to 300°C and Bi to 550°C. The specific conductivities of various compositions of $Bi-BiI_3$ solutions were measured at 500°C and compared with those measured by an electrode method. The accuracy of the method decreased with decreasing conductivity. (auth)

37535 STUDIES ON Zr–Cu–Mo BASE ALLOY. II. THE EFFECTS OF THE FOURTH ALLOYING ELEMENTS ON THE MECHANICAL PROPERTIES AND THE CORROSION RESISTANCE OF Zr–Cu–Mo ALLOYS IN CO_2. Shigeo Aoki (Furukawa Electric Co., Ltd., Japan), Isao Tarora, Ryukichi Hashiguchi, and Yoshitsugu Mishima. Nippon Genshiryoku Gakkaishi, 5: 581-6(July 1963). (In Japanese)

The effects of fourth alloying elements on Zr–Cu–Mo alloys were investigated in order to improve the mechanical properties and the corrosion resistance at high temperatures and high pressures of CO_2. Nb and Bi were found to be excellent as fourth alloying elements. The selected properties were found in the alloys Zr–0.5% Cu–1.0% Mo–1.0% Nb and Zr–0.5% Cu–1.5% Mo–1.0% Bi. These alloys have better mechanical properties than ternary alloys. These properties are also much more improved by the heat treatment. These alloys showed good corrosion resistance at high temperatures and pressures of CO_2 in both cases of as-annealed and after-heat-treatment states. No break-away phenomenon occurred after 2000 hr reaction with CO_2 under pressure of 20 kg/cm^2 at 450°C. (auth)

37536 ACTIVATED SINTERING OF URANIUM DIOXIDE FUEL. III. MEASUREMENT OF LATTICE CONSTANT BY X-RAY. Kunio Suzuki (Mitsubishi Metal Mining Co., Ltd., Japan), Kazuo Maruya, and Tadashi Kubota. Nippon Genshiryoku Gakkaishi, 5: 587-92(July 1963). (In Japanese)

Lattice-constant measurements by x rays of the various UO_2 pellets are described. The lattice constant of UO_{2+x} is $a = (5.4701 - 0.05\ x) \pm 0.0002$ Å, where x ranges from 0 to 0.09. After sintering at 1500°C for 2 hr, UO_2 pellets containing excess oxygen were reduced to $UO_{2.00}$ in either dry or wet hydrogen, whereas in vacuo a minute amount of excess oxygen remains in the sintered pellets. In UO_2, TiO_2 (or lower oxide) is soluble, BeO practically insoluble, Al_2O_3 completely insoluble, and MgO slightly soluble. With MgO the formation of solid solution depends largely upon the amount of excess oxygen of UO_2. (auth)

37537 THE INFLUENCE OF ORDERING ON DIFFUSION OF CADMIUM IN Mg_3Cd ALLOY. Wladyslaw Chomka (Danzig Technical Univ., Poland). Nukleonika, 8: 185-90 (1963). (In Russian)

By means of an integral remainder method and by applying radioactive Cd^{115} isotope, the diffusion coefficients of cadmium in single crystals of Mg_3Cd were measured. The dependence of diffusion coefficients on temperature above and under 155°C was obtained in form: $D_1 = 1{,}2 \cdot 10^{-6} \exp(-12800/RT)$; $D_2 = 4 \cdot 10^{-5} \exp(-16300/RT)$. (auth)

37538 MEASUREMENT OF SURFACE TENSION OF MOLTEN METALS BY ELECTRON BOMBARDMENT HEATING. Susumu Namba and Takehiro Isobe. Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 57: 51-4(June 1963).

By bombarding the bottom end of a vertically supported metal rod by electron beam, a drop of molten metal is produced, growing until the weight of the drop exceeds holding force due to the surface tension of the molten metal. By measuring the weight of the drop that falls, surface tension of the metal in molten state is calculated. The drop-weight method is most accurate of all the methods of measuring surface tension at high temperature. By this method surface tension of refractory metals such as Ta, Mo, Zr, and Ti is measured in vacuum of about 2×10^{-5} mmHg. (auth)

37539 THE CRYSTAL STRUCTURES OF MAGNESIUM-RICH COMPOUNDS IN THE SYSTEMS La–Mg, Ce–Mg, AND Nd–Mg. V. I. Evdokimenko and P. I. Kripyakevich (Franko State Univ., Lvov). Soviet Phys.-Cryst. (English Transl.), 8: 135-41(Sept.-Oct. 1963).

The crystal structures of compounds of the type $La_2Mg_{17}(LaMg_9)$, $Ce_2Mg_{17}(CeMg_9)$, and $NdMg_{12}$ are determined. Results show that the magnesium-rich compounds in the La–Mg and Ce–Mg systems are similar to the corresponding compounds with Ba and Sr. Debye patterns and lattice periods are tabulated. (R.E.U.)

37540 THE TRANSMITTED BEAM IN THE CASE OF ANOMALOUS ABSORPTION OF X RAYS. L. B. Zagarii and V. M. Kardonskii (Bardin Central Scientific Inst. for Ferrous Metallurgy, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 199(Sept.-Oct. 1963).

In investigations connected with anomalous absorption of x rays during interference, the minimum thickness d of a crystal, for which the presence of dynamic effects is revealed, is frequently chosen from the empirical relation $\mu d \geq 10$. X-ray patterns of germanium, d = 0.8 mm, are shown from $CuK\alpha$ radiation. (R.E.U.)

37541 CRYSTAL STRUCTURES OF SOME INTERMETALLIC COMPOUNDS OF GADOLINIUM AND NEODYMIUM. P. I. Kripyakevich, V. F. Terekhova, O. S. Zarechnyuk, and I. V. Burov (Franko State Univ., Lvov

and Baikov Inst. of Metallurgy, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 203(Sept.-Oct. 1963).

X-ray structural investigation is presented for alloys such as Gd–Fe, Gd–Co, Nd–Fe, Gd–Mg, and Gd–Ru. (R.E.U.)

37542 INVESTIGATION OF SUPERCONDUCTING ALLOYS IN THE Nb–Zr SYSTEM. Z. A. Guts, N. M. Reinov, N. I. Krivko, T. A. Sidorova, and A. A. Fogel' (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (English Transl.), 5: 262-4(July 1963).

The region in the Nb–Zr system in which superconductivity occurs in strong (up to 30000 Oe) magnetic fields at 4.2°K was determined. The results of certain mechanical tests and methods of preparation are also given. (auth)

37543 COMPRESSION OF BERYLLIUM SINGLE CRYSTALS ALONG THE HEXAGONAL AXIS IN THE TEMPERATURE RANGE 4.2–900°K. R. I. Garber, I. A. Gindin, and Yu. V. Shubin. Soviet Phys.-Solid State (English Transl.), 5: 315-20(Aug. 1963).

The results of an investigation of the mechanical properties of beryllium single crystals in which the basal plane is at right angles to the compression direction are reported. In the temperature range 4.2-900°K beryllium single crystals of this orientation exhibited unusually high strength: at the temperature of liquid helium the maximum compressive strength reached a value of $\sigma_b = 532$ kg/mm^2. It was found that at high temperatures (500-900°K) beryllium single crystals possessed some plasticity due to slip along the second-order pyramidal planes; at low temperatures plastic deformation was not observed and practically all the deformation before fracture was elastic. (auth)

37544 STUDY OF UNDECORATED DISLOCATIONS IN ZINC SINGLE CRYSTALS BY MEANS OF ION BOMBARDMENT. A. A. Predvoditelev, G. V. Spivak, A. M. Kotova, V. E. Yurasova, and F. F. Kushnir (Moscow State Univ.). Soviet Phys.-Solid State (English Transl.), 5: 394-6(Aug. 1963).

It was found that faceted etch pits are formed at the points of emergence of dislocations upon ion bombardment of the surface of a zinc crystal. The manner in which this method can be utilized for the study of a dislocation structure that has formed in the process of the growth of deformation of a crystal and also for the study of the motion of dislocations is demonstrated. (auth)

37545 SECONDARY ELECTRON EMISSION OF ACTIVATED Al–Mg ALLOYS WITH LOW MAGNESIUM CONTENT AND WITH RARE-EARTH METAL ADMIXTURES. G. B. Stuchinskii. Soviet Phys.-Solid State (English Transl.), 5: 580-1(Sept. 1963).

In an investigation of the secondary-emission properties of activated Al–Mg alloys containing various amounts of Mg, it was found that in order to establish an effective magnesium oxide emitter on the surface of the alloy oxidized at 450-470°C, it was sufficient to have 0.15% Mg in the alloy. On introducing rare-earth (lanthanum, neodymium) admixtures into Al–Mg alloys such an emitter could be produced using only 0.02-0.04% Mg. It is suggested that the rare-earth admixture increases the rate of diffusion of magnesium in Al–Mg alloys containing small amounts of magnesium, and that this ensures the selective oxidation of magnesium on the surface. (auth)

37546 SECONDARY ELECTRON EMISSION OF TUNGSTEN, TANTALUM, AND YTTRIUM OXIDE IN THE PRESENCE OF THERMAL EMISSION CURRENT. A. R. Shul'man, Yu. A. Morozov, and I. N. Petrov (Leningrad Polytechnic Inst.). Soviet Phys.-Solid State (English Transl.), 5: 614-16(Sept. 1963).

The results of measurements on the secondary electron emission coefficient, σ, as a function of the energy V_p of the primary electrons, of the target temperature, and of the length of the primary current pulses for Ta, W, and Y_2O_3 are presented. It is shown that, for the materials investigated, the thermal emission current has no effect on the form of the secondary current pulse. The value of σ is independent of the temperature for metals, and decreases with increase in temperature for yttrium oxide. It was concluded that, having a thermal emission current and high temperatures is a necessary, but not sufficient condition for the occurrence of anomalies in the secondary emission at high temperatures, and that the anomalies come from the specific properties of barium oxide (oxide cathode). (auth)

37547 VACANCY FORMATION IN NIOBIUM. Ya. A. Kraftmakher (Inst. of Thermophysics, Novosibirsk, USSR). Soviet Phys.-Solid State (English Transl.), 5: 696-7(Sept. 1963).

To determine the energy of formation and the concentration of vacancies in Nb, measurements were made of its specific heat at 1300 to 2700°K. For the majority of the specimens the results of the measurements did not differ by more than 1%. The determined value of the energy of vacancy formation in Nb was 47 kcal/g-atom. The vacancy concentration in Nb is described by the expression: $C = 64 \exp(-47000/RT)$ and at the melting temperature it reaches 1.2%. The additional heat capacity of Nb due to the vacancy formation at the melting temperature is 0.57 kcal/g-atom. (P.C.H.)

37548 THE HARDNESS BEHAVIOR OF CHROMIUM ALLOYED WITH GROUP IV-A TO VIII TRANSITION METALS. B. C. Allen and R. I. Jaffee (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Soc. Metals, 56: 387-402 (Sept. 1963).

The room-temperature hardness of iodide chromium containing binary additions of Group IV-A to VIII metals (Ti, Zr, Hf, V, Nb, Ta, Mo, W, Mn, Re, Fe, Ni, Co, Ru, Rh, Pd, Os, Ir, and Pt) up to 65 at. % was investigated. Each alloy series, as arc-cast or homogenized, showed a hardness minimum as a function of alloy concentration near 0.5 at. %. The initial softening amounted to 1 to 20% and was followed by solid-solution hardening. Softening by lowering the elastic modulus or changing the nature of grain boundaries by alloying appeared minor. A plausible explanation based on thermodynamic evidence suggests alloying decreases interstitial solubility. Thus interstitial compound formation takes place at a higher temperature, thereby making agglomeration kinetically more favorable and resulting in overaging and softening. Furthermore, the softening effect was similar in magnitude to nitrogen-induced quench hardening. Group VII-A and VIII but not IV-A to VI-A additions to Cr at about the solid-solubility limits tended to cause mechanical twinning about hardness impressions. Paralleling reported results for W and Mo, increasing the average group number above 6 promotes twinning and suggests alloying decreases the twin boundary energy. Large solid-solution additions of Re to Cr caused significant increases in hardness up to 1100°C. A characteristic hardness break was exhibited at about half the absolute solidus temperature. (auth)

37549 DISPERSION STRENGTHENING IN THE URANIUM–ALUMINA SYSTEM. A. S. Bufferd (New England Materials Lab., Medford, Mass.), K. M. Zwilsky, and N. J. Grant. Trans. Am. Soc. Metals, 56: 508-12 (Sept. 1963).

The feasibility of applying dispersion strengthening to

uranium was demonstrated with uranium-alumina alloys prepared by the mechanical mixing of uranium hydride and alumina powders. Creep-rupture tests indicated significant high-temperature properties of dispersion-strengthened uranium as compared to unalloyed uranium. (auth)

37550 LOW-REDUCTION ROLLING OF BERYLLIUM AND BERYLLIUM–1% COPPER ALLOYS. E. D. Levine (Kennecott Copper Corp., Lexington, Mass.), L. R. Aronin, and S. H. Gelles. Trans. Am. Soc. Metals, 56: 540-9 (Sept. 1963).

The effects of rolling temperature, rolling reduction, and small additions of copper on the mechanical properties of low-reduction beryllium sheet were investigated. Sheet rolled to reduction of 83% at 1400°F exhibits considerably higher transverse ductility than high-reduction sheet, with nearly equivalent yield and tensile strengths. The addition of 1% copper by an electroless plating procedure results in higher strengths, with little sacrifice in transverse ductility. (auth)

37551 MECHANICAL PROPERTIES OF POTENTIAL NUCLEAR REACTOR ALUMINUM CERMET MATERIALS. C. D. Wiseman (Texas Instruments Inc., Dallas), R. N. Duncan, J. W. Lingafelter, and M. E. Snyder. Trans. Am. Soc. Metals, 56: 717-27(Sept. 1963).

Room and elevated temperature tensile tests were conducted on aluminum cermet materials containing various amounts of powdered metal oxide additives. The aluminum particles were in the form of atomized or flake powders and the cermet materials contained controlled amounts of each type. Tensile strengths and ductilities were measured for various processing treatments and as functions of the amount of metal oxide additives and the amount of aluminum flake powders present. The results are explained on the basis of dispersion hardening mechanisms. (auth)

37552 METAL-CERAMIC ALLOYS OF THE ZrC–TaC SYSTEM. V. S. Dergunova, Yu. G. Kolonin, and V. Z. Tseitlin. Tsvetn. Metal., No. 6, 58-63(June 1963). (In Russian)

An analysis was made of the crystal structure and tensile strength of 11 specimens of ZrC–TaC with increasing contents of TaC prepared by sintering and hot pressing. An increasing content of TaC inhibits the tensile strength of the system at 450 to 1200°C. Systems with 75 to 90 wt.% TaC exhibited the highest melting point and tensile strength at temperature to 1200°C. (R.V.J.)

37553 DIFFUSION INVESTIGATIONS IN THE TUNGSTEN–NIOBIUM SYSTEM ON POLYCRYSTALLINE, SINGLE-CRYSTAL, AND SPRAYED COUPLES. I. POLYCRYSTALLINE COUPLES. Erich Gebhardt and Kuno Kirner (Max-Planck-Institut fur Metallforschung, Stuttgart). Z. Metallk., 54: 437-43(Aug. 1963). (In German)

The diffusion in couples of polycrystalline tungsten and niobium was studied by means of the microhardness method. A number of alloy buttons were arc melted, annealed, and hardness checked in order to get a hardness vs. concentration plot from which the hardness values of the diffusion samples could be converted to concentration values. The hardness graph of the completely miscible W–Nb system had a maximum at approximately 40 at.% Nb. The diffusion couples were held at 2100 and 1900°C for times up to 500 hours. The diffusion coefficients were calculated according to the Matano method. They proved to depend very much on the concentration and increased from the W side of the system to the Nb side by two orders of magnitude. $D = 1.6 \times 10^{-7}$ cm²/sec for 10 at.% Nb–90 at.% W, $D = 1.4 \times 10^{-6}$ cm²/sec for 90 at.% Nb–10 at.% W at 2100°C, and $D = 5 \times 10^{-9}$ cm²/sec for 10 at.% Nb–90 at.% W, $D = 1.16 \times 10^{-7}$ cm²/sec for 90 at.% Nb–10 at.% W at 1900°C, respectively. The diffusion coefficient proved to depend strongly on the temperature. From a (log D-1/T) plot the activation energy was calculated. The values were high, compared with the values from other diffusion studies. (auth)

37554 INVESTIGATIONS IN THE NIOBIUM–OXYGEN SYSTEM. I. PROPERTY CHANGES OF NIOBIUM BY DISSOLVED OXYGEN. Erich Gebhardt and Rolf Rothenbacher (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 54: 443-8(Aug. 1963). (In German)

For an investigation of the property changes of niobium due to dissolved oxygen, wires of a purity of more than 99.8 wt.% were completely degassed by holding for 10 min at 2300°C in high vacuum. The degree of degassing of the specimens was tested by measurement of internal friction, electric conductivity, hardness, lattice parameter, and magnetic susceptibility. Different oxygen concentrations were obtained by exposing the specimens for different periods of time at 1460°C and 5×10^{-4} mm Hg of oxygen. The specimens were homogenized and quenched after each engassing treatment. Some properties of the materials were then determined. The specific electric resistivity of degassed Nb at 0°C was 13.43 μΩcm and increased linearly with the amount of dissolved oxygen. The temperature-independent additional resistivity was 4.1 μΩcm. The temperature and concentration dependence of the electric resistivity between 0 and 1000°C, and between 0 and 1.8 at.% O followed the relation $\rho_{c_i,T} = 13.43\ (1 + 3.2 \times 10^{-3}\ T - 5.5 \times 10^{-7}\ T^2 + 0.305\ c)$ μΩcm (T in °C). Therefore the validity of Matthiessen's rule was confirmed for the investigated ranges. Microhardness increased over sixfold in increasing oxygen content from 0 to 5.5 at.%. The lattice parameter increased linearly from 3.3001 Å at 0 to 3.3175 Å at 4.2 at.% oxygen and the specific magnetic susceptibility decreased linearly from 2.28_3 to 2.00×10^{-6} cm³/g at 5.0 at.% oxygen. (auth)

37555 CONCERNING THE RECRYSTALLIZATION BEHAVIOR OF ELECTRON-BEAM-MELTED NIOBIUM. Ingard Kvernes (Zentralinstitut für Industrielle Forschung, Oslo). Z. Metallk., 54: 449-51(Aug. 1963). (In German)

The recrystallization behavior of electron-beam-melted 99.86 wt.% niobium was investigated by metallography, hardness measurement, and x-ray diffraction. The temperatures for the start of recrystallization were determined for 25, 50, 75, and 90% plastic deformation. The activation energy of recrystallization of the electron-beam-melted niobium was estimated from these experiments. (auth)

37556 THE STRUCTURE OF SOLID TANTALUM–RUTHENIUM ALLOYS. Ernst Raub, Hans Beeskow, and Walter Fritzsche (Forschungsinstitut für Edelmetalle und Metallchemie, Schwabisch Gmund, Ger.). Z. Metallk., 54: 451-4(Aug. 1963). (In German)

The system Ta–Ru resembles the systems Ru–V and Ru–Nb. There is a transition of the bcc solid solution to an ordered B2 structure at a certain Ru content, which becomes tetragonally distorted at still higher Ru concentration. Finally, ordered orthorhombic cell forms. On the ruthenium-rich side an ordered fc tetragonal phase forms. The phase fields of these phases were approximately determined. (auth)

37557 THE ALLOYS OF RUTHENIUM WITH TITANIUM AND ZIRCONIUM. Ernst Raub and Erich Roeschel (Forschungsinstitut für Edelmetalle und Metallchemie, Schwabisch Gmund, Ger.). Z. Metallk., 54: 455-62(Aug. 1963). (In German)

The formation of intermediate B2 phases TiRu and ZrRu as well as the C14 type Laves phase $ZrRu_2$ was confirmed. TiRu and ZrRu melted congruently at a temperature of 2100 to 2150°C. They showed no phase transformation or decomposition at lower temperatures. $ZrRu_2$ decomposed by a eutectoid reaction at 1300 ± 20°C. The solubility of Ru in α-Ti and α-Zr was small; in β-Ti and β-Zr it was considerably larger. β-Ti was stabilized by addition of Ru so that the temperature of the $\beta \rightarrow \alpha$ transformation could be moved below room temperatures for alloys with 16 to 20 at.% Ru. The investigation of the Zr-Ru alloys in the concentration range of the $\beta \rightarrow \alpha$ transformation was difficult due to the high affinity of Zr to oxygen. These alloys behaved as ternary alloys. The transformation and precipitation processes in the titanium-rich alloys may lead to considerable precipitation hardening. (auth)

37558 INVESTIGATION WITH THE ELECTRON-BEAM MICROANALYZER OF THE PRESSURE-SINTERED TANTALUM CARBIDE WITH SMALL MANGANESE AND NICKEL ADDITIONS. Erwin Roeder (Philips Zentral-laboratorium GmbH, Aachen) and Max Klerk. Z. Metallk., 54: 462-70(Aug. 1963). (In German)

The influence of temperature on the local distribution of small additives of manganese and nickel in hot-pressed tantalum carbide was determined in the range between 1400 and 2600°C. The investigation was done by electron-probe x-ray-emission microanalysis supplemented by metallographic examinations and quantitative chemical analysis. The results indicated that the tantalum carbide matrix has a much higher solubility for manganese than for nickel, and consequently less manganese is available to form the grain-boundary phase. Some information is given on the comparative effect of both metals on the process of densification and on grain growth. Exact quantitative determinations of the local concentration of the added metal were difficult as a consequence of uncertainties in the interpretation of the x-ray intensity measurements. (auth)

37559 CONCERNING THE STRUCTURAL AND CONSTITUTIONAL RELATIONS BETWEEN THE INTERMETALLIC PHASES UFe_2, UCo_2, AND UMn_2. Guenter Petzow, Siegfried Steeb, and Gonde Kiessler (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 54: 473-7 (Aug. 1963). (In German)

Crystal structure and constitution of the intermetallic phases UFe_2, UCo_2, and UMn_2 were investigated by chemical, thermal, x-ray, and metallographic methods. There is complete miscibility between these phases in the solid state. As a consequence the ternary systems of U with Fe, Co, and Mn contain three quasi-binary sections, namely, UFe_2-UCo_2, UCo_2-UMn_2, UMn_2-UFe_2, and the quaternary system U–Fe–Co–Mn contains the quasiternary section $UFe_2-UCo_2-UMn_2$. (auth)

37560 SUPERCONDUCTIVITY OF TITANIUM AND ITS ALLOYS. Ulrich Zwicker (Forschungsinstitut für Edelmetalle und Metallchemie, Schwabisch-Gmund, Ger.). Z. Metallk., 54: 477-83(Aug. 1963). (In German)

The major difficulty of a treatment of superconductivity of Ti and its alloys is that they are not very well defined with respect to their microstructure and impurity content. The results of former investigations indicated the validity of the rule which Matthias proposed with only a few exceptions. This rule was also confirmed for solid solutions of the two modifications of Ti with transition elements. Not enough alloys were investigated with respect to superconductivity for a final interpretation. Ti-rich Ti–Nb alloys wires reach a high critical current density and field strength, which correspond to the values reached in Nb–Zr wires and surpasses the values of this alloy at high field strength. Another advantage of this alloy is its good workability. The lamellar microstructure is supposed to be the reason for the high values of the critical current and field strength. (auth)

37561 ELECTRIC RESISTANCE AND THERMOELECTRIC POWER OF URANIUM DURING OXIDATION AT 10^{-3} TORR AND 200 TO 400°C. Siegfried Steeb and Rolf Rossberg (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 54: 483-9(Aug. 1963). (In German)

An apparatus is described for the production of thin films of uranium by evaporation and for the consequent measurement of electric conductivity and thermoelectric power. Uranium films were treated between 200 and 400°C with oxygen (10^{-3} Torr), and at the same time the electric conductivity and thermoelectric power were measured. The band model was used for the interpretation of the resistance vs. time curves. Valence and conduction bands were 3 ev apart, while the acceptor and donor levels were 0.5 or 0.55 ev distant from the band above or below. These values were obtained from the measured temperature-resistance curves. The measurement of thermoelectric power showed that uranium oxides exhibit p-type conductivity at small oxygen contents and n-type conductivity at larger oxygen contents. The absolute values of thermoelectric power against platinum are given, as well as its dependence on the oxygen content. It is important for practical application that the thermoelectric power have a temperature-dependent maximum at a certain uranium/oxygen ratio. The behavior of electric resistivity and thermoelectric force caused by interruption of the oxygen treatment is discussed. Samples which were oxidized to saturation at 400°C show better thermoelectric properties in vacuum than sintered bodies of uranium oxide. (auth)

37562 SHIFT OF THE FERROMAGNETISM-ANTIFERROMAGNETISM TRANSITION POINT IN DYSPROSIUM UNDER THE EFFECT OF UNIFORM PRESSURE. K. P. Belov, S. A. Nikitin, and A. V. Pedko (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 26-8(Aug. 1963). (In Russian)

Uniform pressure of 1800 atm shifts the ferromagnetism-antiferromagnetism point in dysprosium towards lower temperatures by approximately 7°. The shift is ascribed to the effect of the change in the interatomic distances on exchange interaction between atoms lying in the base planes of the hexagonal lattice. As a result the temperature interval in which a magnetic helical arrangement in the base planes exists expands towards lower temperatures. (auth)

37563 GALVANOMETRIC PROPERTIES OF BERYLLIUM. N. E. Alekseevskii and V. S. Egorov (Inst. of Problems in Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 388-91(Aug. 1963). (In Russian)

Galvanometric properties 0.3 × 0.5 × 5 mm beryllium monocrystals of various orientation were studied at liquid helium temperature and in constant and pulsed electromagnetic fields. Rotation diagrams and resistance as functions of field strength are given for various crystalline orientations. It is shown that a beryllium Fermi surface consists of two parts: holes and electrons. The two parts are equal in less than 35 k gauss fields; in fields up to 50 k gauss the Fermi surfaces exhibit directions parallel to the hexagonal axis. (R.V.J.)

Radiation Effects

Refer also to abstracts 37701, 37784, 37801, and 38459.

37564 (BMI-1646) FISSION-FRAGMENT-INDUCED EXPANSION IN SINGLE-CRYSTAL ALPHA ALUMINA. Thomas S. Elleman, Robert B. Price, and Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). Sept. 4, 1963. Contract W-7405-eng-92. 11p.

Fission fragments were recoiled into flat Al_2O_3 specimens, and the height of the expansion step formed at the boundary between irradiated and unirradiated regions of the surface was measured by interferometry techniques. Expansion normal to the surface was found to be independent of crystal orientation for specimens cut along three different axes. Expansion was not a linear function of fission-fragment concentration as a factor of ten increase in exposure produced only a factor of three increase normal to the specimen surface were at least three times larger than expansion coefficients calculated from the bending moment of thin, fission-fragment-irradiated Al_2O_3 disks. This result indicates that fission-fragment-induced expansion is not isotropic but that the stresses are preferentially relieved by expansion normal to the free surface. (auth)

37565 (EURAEC-274) SWELLING OF URANIUM. Quarterly Report No. 5, October 1 and December 31, 1961. (Mol, Belgium. Centre d'Etude de l'Energie Nucleaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 022-60-10 RDB. 16p. (R-2083)

A description is given of further transmission electron microscope studies of dislocations and radiation damage in thin uranium and platinum foils. Both zone refined pure α-uranium and uranium containing 1.5 wt % chromium were examined. The α-uranium foils were pretreated by annealing and subsequent rapid cooling to room temperature. The uranium foils with chromium content were β-treated and subsequently quenched in order to retain the β phase at room temperature. The platinum foils were of the same material as used before. The foils were irradiated with α particles and the annealing behavior of damage was examined. It was found that the annealing behavior of α particle-irradiated foils was markedly different from that of foils exposed to fission fragments. Mild annealing below 500°C gave rise to large polygonal loops. At temperatures higher than 500°C where the helium becomes sufficiently mobile, cavities are formed. These cavities are rather similar in aspect to the cavities observed in quenched foils. A discussion is added on the nature of radiation-induced loops with respect to the results so far pertained in the study on platinum. (auth)

37566 (FZK-142) INVESTIGATION OF COMBINED EFFECTS OF RADIATION AND VACUUM ON ENGINEERING MATERIALS. Quarterly Progress Report No. 1, November 9, 1962 through February 8, 1962. E. E. Kerlin and E. T. Smith (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Mar. 20, 1962. Contract NAS8-2450. 52p.

Thermal insulation materials, potting compounds, structural adhesives, and plastic laminates applicable for combined radiation and vacuum tests were surveyed. An experimental test apparatus for measuring the weight loss of 15 samples continuously and remotely during irradiation was designed. A preliminary design was also made for an apparatus to measure degradation of bearing lubricants during irradiation. Data on individual materials are tabulated. (P.C.H.)

37567 (FZK-161-2(Vol.II)) INVESTIGATION OF COMBINED EFFECTS OF RADIATION AND VACUUM AND OF RADIATION AND CRYOTEMPERATURES ON ENGINEERING MATERIALS. VOLUME II. RADIATION-CRYOTEMPERATURE TESTS. Annual Report, November 9, 1961 through November 8, 1962. E. T. Smith (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Jan. 5, 1963. Contract NAS8-2450. 260p.

A series of tests was performed to measure the combined effects of nuclear radiation and cryotemperatures on a group of nonmetallic spacecraft materials. This group consisted of materials classified as adhesives, seals, thermal insulations, electrical insulations, structural laminates, and thermal-control coatings. Typical tests performed on specimens prepared from the materials included lap-shear strength, ultimate tensile strength, ultimate elongation, stress-strain characteristics, and compressive strength. Special test equipment to submerge the specimens in liquid nitrogen or liquid hydrogen during irradiation and to subsequently perform the above tests was designed and built at General Dynamics/Fort Worth. Measured properties of the materials as a function of integrated neutron flux and gamma dose are reported and recommendations for use of the various materials in nuclear-powered spacecraft are made. (auth)

37568 (GA-4224) EFFECT OF FURFURYL ALCOHOL IMPREGNATION ON IRRADIATION STABILITY OF GRAPHITE. G. B. Engle, G. R. Tully, B. F. Disselhorst, and W. P. Wallace (General Atomic Div. General Dynamics Corp., San Diego, Calif.). June 11, 1963. Contract AT(04-3)-314. 25p. (CONF-73-14)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

Dimensional contraction of impregnated and base stock HLM-85 graphite ranged from 0.25 to 0.65% in the perpendicular direction and from 0.84 to 1.60% in the parallel direction when irradiated at 650 and 1000°C to 7×10^{21} nvt (E > 0.18 Mev). The diameters of disk samples cut from the wall of a full-size impregnated HLM-85 sleeve contracted 0.20 and 0.10% when irradiated at 550 and 900°C, respectively, to 1.65×10^{21} nvt (E > 0.18 Mev). Electrical resistivity was increased by a factor of about 1.5 to 3. Thermal expansion coefficients were increased about 10% in the parallel direction. Line broadening of (002) line profiles was observed for samples irradiated at 650 and 1000°C but the C_0 spacing was relatively unchanged. The impregnation treatment had little effect on the changes in properties, which result from fast-neutron bombardment. (auth)

37569 (GA-4287) EFFECT OF NEUTRON IRRADIATION ON MATERIALS SUBJECTED TO MULTIAXIAL STRESS DISTRIBUTIONS. Annual Summary Report, April 1, 1962–March 31, 1963. George Buzzelli, P. W. Flynn, and T. A. Trozera (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 13, 1963. Contract AT(04-3)-167. 27p.

A research program is being conducted on the extrapolation of tensile data to the actual, more complicated stress states in reactor materials. The program will involve tube tests under both axial load and internal pressure on irradiated ASTM A-302 Grade B steel. Capsule design and flux-monitor measurements are reported. Experimental results are reported for the following tests: tensile and notched tensile tests on unirradiated specimens and Charpy

impact tests on irradiated specimens. A theoretical analysis of stresses in a tube subjected to internal pressure and axial load is presented which shows that any stress system different from simple tension leads to a plastic instability. (D.L.C.)

37570 (GA-4484) EFFECT OF NEUTRON IRRADIATION ON MATERIALS SUBJECTED TO MULTIAXIAL STRESS DISTRIBUTIONS. Quarterly Progress Report, April 1–June 30, 1963. T. Trozera and P. W. Flynn (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Aug. 1963. Contract AT(04-3)-167. 9p.

Results are reported for tensile and notched tensile tests on unirradiated and irradiated A-302B steel. The tensile results indicate that neutron irradiation decreases the uniform strain, increases the yield point, and decreases the strain hardening. The notched tensile results showed an increase in the ultimate tensile strength with irradiation. (D.L.C.)

37571 (HW-76642) RADIATION EFFECTS ON ALUMINUM FILMING AND CORROSION. R. B. Richman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 20, 1963. Contract AT(45-1)-1350. 20p.

Film deposition and corrosion were measured for aluminum samples exposed to a wide range of intensities of nuclear reactor radiation in pH 7.0, treated, Columbia River water preheated with steam to 90°C. Both the amount of film deposited and the extent of aluminum corrosion increased with radiation intensity. The film on samples in radiation regions was also darker and more brittle than the film on samples tested in the same environment without any radiation. (P.C.H.)

37572 (HW-78178) YIELDING BEHAVIOR OF NEUTRON-IRRADIATED NICKEL. J. J. Laidler (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 10, 1963. Contract AT(45-1)-1350. 20p.

Nickel specimens representing two levels of solute atom concentration were irradiated in a reactor flux and subjected to tensile testing. Solute atom content has an effect on the distribution of defects, and this difference in defect distribution manifests itself in a striking deviation in the tensile behavior of nickel after irradiation. The effect of solute atom content is also demonstrated for unirradiated nickel. The Portevin-LeChatelier effect was observed in material with higher solute atom concentration, and is interpreted as an impedance of moving dislocations and formation of a Cottrell atmosphere on the retarded dislocations, followed by a pile-up and cross-slip of dislocations in the pile-up. After irradiation, the Portevin-LeChatelier effect was not observed, probably due to immobilization of solute atoms by trapped vacancies. (auth)

37573 (REIC-ACCESS-63) RADIATION EFFECTS INFORMATION CENTER MONTHLY ACCESSION LIST — ABSTRACTS. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). May 15, 1963. 84p.

Abstracts are presented for 149 articles which were accessioned and extracted for the REIC Technical Information File from April 1 to 30, 1963. The abstracts are arranged according to facilities, material types, space environment, experimental devices and techniques, and electronic equipment. (D.L.C.)

37574 (WAPD-T-1570) ANOMALOUS EMBRITTLING EFFECTS OBSERVED DURING IRRADIATION STUDIES ON PRESSURE VESSEL STEELS. G. F. Carpenter, N. R. Knopf, and E. S. Byron (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). [1962]. Contracts [AT(11-1)-Gen-14] and NObs-78844. 70p. (CONF-39-94)

From American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963.

The effects of neutron irradiation, post-irradiation annealing, and re-irradiation on the Charpy V-notch impact transition temperature of pressure vessel steels were investigated. Specimens representing several heats of pressure vessel steels were irradiated at elevated temperatures to fast (>1 Mev) neutron exposures up to 2×10^{19} nvt. The general observation was that irradiation caused an increase in the transition temperature; however, it was discovered that specimens representing various heats of a given material composition could show a vastly different increase in transition temperature due to irradiation. These results have led to the arbitrary classification of these steels as "sensitive" or "insensitive" heats. Possible correlation of heat to heat sensitivity with microstructure is discussed. Post-irradiation annealing in the temperature range of 650 to 800°F was found to reduce the effects of irradiation on the transition temperature significantly. However, subsequent re-irradiation of specimens which were post-irradiation annealed at 650°F increased the transition temperature to the level that would be expected if no intermediate anneal has been performed. Re-irradiation studies were not conducted on specimens that were post-irradiation annealed at the higher temperatures. No explanation of the re-irradiation behavior after annealing is available. (auth)

37575 (FTD-TT-63-424) THE CHANGE IN THE MAGNETIC PROPERTIES OF SOLID INORGANIC COMPOUNDS IN A FIELD OF INTENSE γ-RADIATION. S. V. Starodubtsev and I. M. Blaunshtein (Blaunshteyn). Translated from Tr. 2-go [Vtorogo] Vses. Soveshch. po Radiats. Khim., Akad. Nauk SSSR, Otd. Khim. Nauk, Moscow, 1960, 683-8(Pub. 1962). 10p.

A qualitative study was made of the effects of Co^{60} gamma rays on the magnetic susceptibility of ionic compounds, ion-covalent crystals, and substances with semiconductor properties. The ionic compounds $BaCl_2$, KI, and NaCl do not show any change, while the diamagnetism of $NaNO_3$ and KNO_3 decreases. Most of the antiferromagnetic compounds have an increased paramagnetism, while Co_2O_3 and $CoCl_3$ show a decrease. The semiconductor compounds and elements have an increase in diamagnetism. The probable causes of the changes are discussed. (D.L.C.)

37576 EFFECT OF IRRADIATION ON THE PLASTICITY OF METAL CRYSTALS. K. Lintner (Universität, Vienna). Acta Phys. Austriaca, 16: 256-64(1963). (In German)

Zinc crystals with a purity of 99.995% were used to study the effects of neutron, β, and γ irradiation on plasticity. Flow curves could be obtained on the same crystals before and after irradiation. Typical flow curves obtained with Rn + Be, P^{32}, Rn, and lead-shielded Rn + Be and Rn sources are given. They show that γ radiation does not affect the plastic behavior of the crystal. Neutron irradiation causes a solidification and β irradiation a softening. The energy dependence of the softening effect of β radiation was measured, and the results are discussed. (J.S.R.)

37577 VOLTAGE-ANNEALING OF RADIATION DAMAGE IN TUNNEL DIODES. H. Roth, W. Bernard, P. Zeldes, and A. P. Schmid (Raytheon Research Div., Waltham, Mass.). J. Appl. Phys., 34: 669-71(Mar. 1963).

A unique radiation damage annealing process was observed at 78°K in tunnel diodes bombarded with high-energy electrons. Approximately one half of the radiation-

induced excess current in germanium tunnel diodes can be permanently removed by application of forward bias voltages. This voltage-annealing effect arises from the enhanced migration of charged lattice defects under the influence of the high electric fields present in degenerate semiconductor junctions. A tentative model, based on known deep-lying radiation damage levels, is proposed. Under suitable conditions of forward bias, a charged interstitial can be dissociated from its adjacent paired vacancy, allowing the now isolated interstitial to be swept from the junction region with an estimated activation energy of 0.25 ev. (auth)

37578 GAMMA-RAY INDUCED CONDUCTIVITY IN POLYETHYLENE AND TEFLON UNDER RADIATION AT HIGH DOSE RATE. Kichinosuke Yahagi and Akibumi Danno (Japan Atomic Energy Research Inst., Tokyo). J. Appl. Phys., 34: 804-9(Apr. 1963).

The conductivity induced by gamma radiation from Co^{60} was measured for polyethylene and Teflon as functions of temperature, dose rate, and applied voltage. The range of dose rates was from about 10^3 to 10^5 R/h and of the temperature from 190 to 300°K. The value of Δ, which shows the dependence of the induced current i on the dose rate R, i.e., $i \propto R^{\Delta}$, varies from 1 (characteristic of the monomolecular recombination) to ½ (characteristic of the bimolecular recombination) with decreasing temperature. In both polymers, below about 240°K the induced current at a thermal equilibrium was independent of temperature, although it was slightly increased with decreasing temperature. From the investigation of temperature and dose-rate dependences, it is considered that the thermal electrons are dominant as charge carriers above 230°K, but fast electrons at below that temperature. (auth)

37579 ION BOMBARDMENT OF SILICON. W. Primak, Y. Dayal, and E. Edwards (Argonne National Lab., Ill.). J. Appl. Phys., 34: 827-30(Apr. 1963). (TID-16873; UAC-6594)

When silicon plates were bombarded with protons of energies about 100 kv, the infrared absorption spectrum above 1.1 μ showed chromatic fringes corresponding approximately to the range of the protons. The fringes did not begin to disappear on annealing until the plates were heated to over 1100°C. The effect appears to be caused by a reflecting layer involving trapped hydrogen. After long irradiation, small flat-bottomed pits were found of about the depth of the range. The effect could also be produced with helium ions on silicon. No effect was found with germanium. (auth)

37580 EFFECT OF FAST-NEUTRON IRRADIATION ON THE PRESSURE AND TEMPERATURE DEPENDENCE OF THE ELASTIC MODULI OF SiO_2 GLASS. R. E. Strakna, A. E. Clark, D. L. Bradley, and W. M. Slie (Naval Ordnance Lab., White Oak, Silver Spring, Md.). J. Appl. Phys., 34: 1439-43(May 1963).

The low-temperature ultrasonic attenuation, the elastic moduli, and the temperature and pressure dependence of the moduli of SiO_2 glass are modified by heavy fast-neutron irradiation. A sample of Amersil optical-grade fused silica was irradiated to an integrated flux density in excess of 5×10^{19} n/cm^2. In this sample the ultrasonic loss is decreased by about 85%, the shear modulus increased less than 2%, and the compressibility decreased by about 20%. The anomalous temperature dependence of the compressibility changed from -3.3×10^{-2}% per °K before irradiation to -9.5×10^{-3}% per °K after irradiation over a temperature range of from 100 to 300°K. The anomalous pressure dependence of the compressibility changed from 7.35×10^{-2}% per atm before irradiation to 2.86×10^{-2}% per atm after irradiation over a pressure range from atmospheric pressure to 5×10^4 psi. Similar effects were found in the pressure and temperature dependence of the shear modulus. The effect of γ irradiation on the low-temperature ultrasonic loss and on the temperature dependence of the sound velocity in this glass was also studied. No change in the ultrasonic attenuation was detected at an irradiation level several orders of magnitude larger than that required to eliminate effectively the comparable 50°K loss peak in synthetic quartz. (auth)

37581 HARDENING OF POTASSIUM CHLORIDE SINGLE CRYSTALS BY QUENCHING AND IRRADIATION. Kazou Akimoto and W. A. Sibley (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 34: 1767-70(June 1963).

The effect of heat treatment and irradiation on the hardening properties of potassium chloride single crystals of varying impurity concentrations is investigated. Some specimens were quenched in cold acetone (0°C) from temperatures over the range of 100 to 650°C, and other samples were irradiated with Co^{60} photons or with 1.5-Mev electrons to doses of 10^{19} photons or about 3.8×10^{15} electrons, respectively. The quenching results are most easily explained in terms of the dissociation of vacancy-impurity complexes for temperatures to 375°C. It was not possible at the quenching rate utilized, to quench thermal vacancies in the lattice. Also, even for quench temperatures below 375°C, there is evidence that some annealing out of the defects occurred. The irradiation results show that relatively impure samples have quite different hardening properties for a given dose of irradiation, electron or gamma, than do the purer specimens. (auth)

37582 OXYGEN OUTGASSING CAUSED BY ELECTRON BOMBARDMENT OF GLASS. Jack L. Lineweaver (Corning Glass Works, Corning, N. Y.). J. Appl. Phys., 34: 1786-91(June 1963).

A system employing a mass spectrometer as a continuous flow gauge was used to study the oxygen evolved from aluminum-coated glass as a result of electron bombardment. The outgassing from most glasses is found to fit the empirical equation $Q = Q_\infty(1 - \exp\text{-}t/K)$. In this equation Q is the sum of the oxygen released during the bombardment time t and that evolved during a subsequent thermal outgas and Q_∞ is the maximum amount of oxygen expected from a sample bombarded for long times. Experimental results from Code 8603 glass indicate that Q_∞ is a measure of the range of 10 to 27-kev electrons in glass, K varies inversely with electron current per unit mass of glass affected, and that electron current density may have a secondary effect on electron range in bulk glass. Oxygen outgassing data are presented from 12 commercial glasses subjected to 150 μamp of 20-kev electrons bombarding a $3 \times 3/4$-in. area. A mechanism of oxygen release is proposed that involves the dissipation of electron energy, the charge produced in the glass by the electrons, and the availability of nonbridging oxygen atoms in the glass structure. (auth)

37583 DISLOCATION BEHAVIOR AND THE YIELD STRESS IN NEUTRON-IRRADIATED MgO. Paul F. Stablein (Argonne National Lab., Ill.). J. Appl. Phys., 34: 1867-71(July 1963).

Mechanical property measurements on neutron-irradiated MgO single crystals show that hardening is caused by fast neutrons exclusively. Microhardness measurements, followed by etching to reveal dislocation distribution, permit

an analysis of plastic flow even on samples that are so embrittled by the irradiation (with a dose of 10^{19} nvt) that it was not possible to bend them. As determined from 3-point bending experiments on samples annealed at temperatures up to 1200°C, it does require an increasingly higher stress to form a dislocation (source hardening) as well as to move it through the damaged lattice (friction hardening). The type of defects responsible for such behavior are discussed. (auth)

37584 POLARIZATION OF DIELECTRICS BY NUCLEAR RADIATION. I. RELEASE OF SPACE CHARGE IN ELECTRON IRRADIATED DIELECTRICS. Preston V. Murphy and Sergio Costa Ribeiro (Universidade Católica, Rio de Janeiro). J. Appl. Phys., 34: 2061-3(July 1963).

Irradiation of solid dielectrics with high-energy electrons produces a region of negative space charge that may persist for a long time. The capacity of various dielectrics for charge storage and the characteristics of thermal and photoelectric charge release are discussed. Charge storage capacity is highest in electret forming materials and in materials with a high density of deep traps. (auth)

37585 DISTRIBUTION OF ELECTRON-BOMBARDMENT-INDUCED RADIATION DEFECTS WITH DEPTH IN SILICON. H. Flicker (RCA Labs., Princeton, N. J.) and J. J. Loferski. J. Appl. Phys., 34: 2146-9(Aug. 1963).

The electron-voltaic effect in commercial silicon p–n junctions is used to determine the distribution of radiation defects with penetration distance for a 500-kev electron beam in n-type silicon. It is shown that the concentration of radiation defects falls off far more rapidly than previously reported by Vavilov, who used changes in resistivity to determine the distribution. Their experimental data are reinterpreted and found to be in reasonable agreement with the electron-voltaic data. Attempts are made to explain the experimental data by constructing radiation defect vs depth curves using various relations for the probability of defect formation of electron energy, and for electron energy as a function of penetration distance. Reasonable agreement exists between such theoretical curves and the experimental data. (auth)

37586 SOME PRELIMINARY RESULTS ON DEFECTS IN IRRADIATED UO_2 SINGLE CRYSTALS AS REVEALED BY TRANSMISSION ELECTRON MICROSCOPY. H. Blank and S. Amelinckx (SCK-CEN, Mol, Belg.). J. Appl. Phys., 34: 2200-9(Aug. 1963).

Vapor-grown single crystals of nearly stoichiometric UO_2 were thinned for transmission electron microscopy. The vapor-grown crystals show a dense pattern of precipitates and may contain loops due to quenched-in vacancies but contain hardly any dislocations. Two models for the production of loops are proposed. Dislocation networks (small angle boundaries) are produced on annealing the crystals. Irregular patterns of dislocations arise when sufficient thick parts of the crystal foils are treated with heat shocks in the microscope suddenly increasing the beam current. After exposure to 10^{15} nvt the crystal foils show fission tracks, short segments of straight dislocation lines and black dots, which are partly distributed at random and partly are aligned on fission tracks. Interaction between fission tracks and dislocations was observed. The conditions for contrast production on fission tracks were investigated. The experimental findings can be explained by a model of a displacement field around the fission tracks. (auth)

37587 ESTIMATION OF THE EFFECT OF DIFFERENTIAL FUEL SWELLING. W. S. Blackburn (C. A. Parsons and Co. Ltd., Newcastle-upon-Tyne, Eng.). J. Nucl. Energy, Pt. A & B, 17: 253-5(Aug. 1963).

When there is a large difference between the core and rim temperatures of a fuel, the creep strength at the surface may be much greater, and the unrestricted swelling there may be much less than at the center. In these circumstances appreciable pressures (100 to 500 lb/in^2) will exist near the center. The swelling and the ratio of this central pressure to absolute temperature are functions of the product of the absolute temperature and the creep rate per unit stress and dose, when the unrestrained swelling after a particular dose is given. For a material in the range 410 to 500°C, a small homogeneous specimen of which would swell 20 per cent after 2000 Mwd/t, this pressure would increase by about half in the absence of the surface tension restraint. (auth)

37588 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON CRYSTAL LATTICE DEFECTS, CONFERENCE, KYOTO-2, SEPTEMBER 7-12, 1962. J. Phys. Soc. Japan, 18: Suppl. III, 1-373(Mar. 1963).

Seventy-two articles are included: separate abstracts were prepared for 44; 8 articles on linear imperfections in Cd crystals, effect of solute atoms on vacancy climb of prismatic dislocations in Al–Mg, dielectric properties and point defect interaction, dynamics of radiation damage, radioinduced lattice defects in quartz, interstitial configuration in noble metals, theory of point defect annealing in metals, and radiation effects on LiF crystals were previously abstracted in NSA. The 20 articles not abstracted include information on interactions between defects in metals and non-metals, and vacancies in germanium properties of quenched-in vacancies. (P.C.H.)

37589 POINT DEFECT CLUSTERING IN NICKEL. I. G. Greenfield and H. G. F. Wilsdorf (Franklin Inst. Labs., Philadelphia). J. Phys. Soc. Japan, 18: Suppl. III, 20-6(Mar. 1963).

Point defects were introduced into nickel by neutron bombardment and quenching. Irradiations of 1×10^{18} nvt (total fast flux) were carried out at 70 and 200°C, and the quenching treatments were varied by quenching to temperatures ranging from –10°C to above the Curie temperature. From the results obtained, it was concluded that, because of local regions of damage that act as nucleation sites, prismatic dislocation loops are more easily formed in irradiated nickel than in quenched nickel. (auth)

37590 NUCLEATION OF STACKING FAULT TETRAHEDRA IN GOLD. W. Westdorp and R. Maddin (Univ. of Pennsylvania, Philadelphia). J. Phys. Soc. Japan, 18: Suppl. III, 37-41(Mar. 1963).

Electron microscopic observations of the density and size of tetrahedra in quenched and annealed gold foils for two quenching temperatures (900 and 980°C) each at one annealing temperature (100 and 174°C) show an increase in the density of tetrahedra as a function of annealing time but no change in tetrahedra size with annealing time. Based upon the data, calculations were made to show that the nucleation of tetrahedra is the rate controlling step in their growth. The activation energy of the process is calculated as 1.22 ± 0.13 ev (T_Q = 900°C, T_A = 100°C) and 1.05 ± 0.13 ev (T_Q = 980°C, T_A = 174°C). (auth)

37591 THE ANNEALING OF CLUSTERED-VACANCY DEFECTS IN QUENCHED AND NEUTRON-IRRADIATED GOLD. R. M. J. Cotterill (Cavendish Lab., Cambridge, Eng.). J. Phys. Soc. Japan, 18: Suppl. III, 48-50(Mar. 1963).

The results of correlated electrical resistivity and

electron microscope observations on the annealing of defects produced in gold by quenching or irradiation are reported. The plateau from 200 to 300°C on the quench curve corresponded to the black spot defects, while the second plateau, from 375 to 450°C, corresponded to tetrahedra many of which appeared in pairs. The results indicate that during annealing the larger black spot defects coarsen at the expense of the smaller ones until tetrahedra are formed. Both loops and black spot defects survive the first annealing stage, at about 200°C, in the irradiated gold. (P.C.H.)

37592 QUENCHED-IN VACANCIES IN DILUTE ALUMINIUM–MAGNESIUM ALLOYS. J. Takamura (Kyoto Univ.), K. Okazaki, and I. G. Greenfield. J. Phys. Soc. Japan, 18: Suppl. III, 78-85(Mar. 1963).

Electron-microscope observations of the development of prismatic dislocation loops due to quenched-in vacancies in dilute aluminum–magnesium alloys were made in connection with measurements of the dimensional changes of quenched specimens. From this information direct evidence for the collapse of vacancy clusters into prismatic dislocation loops was obtained. The retardation of the development of prismatic loops during room temperature annealing in aluminum–magnesium alloys in comparison with pure aluminum was interpreted in terms of binding between a vacancy and a magnesium atom; the binding energy was estimated to be 0.20 ev from the quenched-in resistivity measurement of alloys having 0.1 and 0.5 at. % magnesium. It was also concluded that the contribution of vacancies associated with magnesium atoms to electrical resistivity is smaller than that of free vacancies in pure aluminum. (auth)

37593 THE INFLUENCE OF RADIATION-PRODUCED DEFECTS ON THE PRECIPITATION OF CARBON IN IRON. F. E. Fujita and A. C. Damask (Brookhaven National Lab., Upton, N. Y.). J. Phys. Soc. Japan, 18: Suppl. III, 105-9 (Mar. 1963). (BNL-6133)

The effect of radiation enhanced nucleation was studied in the iron-carbon system. Measurements were made by electrical resistivity, internal friction, and electron microscopy. Two effects were found. When the alloy is irradiated at ambient temperature (~60°C) the number of precipitation particles formed and, hence, the rate of precipitation of carbon, is ten times the number in the unirradiated alloy. Further irradiation does not increase the number of precipitate particles. When the alloy is irradiated at low temperature (~–100°C) the disappearance of carbon from solution is one thousand times faster than the thermal rate. It was deduced that the carbon is temporarily trapped by vacancies and later released to precipitate at a temperature higher than the precipitation temperature in the unirradiated alloy. (auth)

37594 PIPE DIFFUSION IN LiF. R. Tucker, A. Laskar, and R. Thomson (Univ. of Illinois, Urbana). J. Phys. Soc. Japan, 18: Suppl. III, 120-3(Mar. 1963).

The impurity diffusion of Na ions along dislocations in LiF was studied by both d-c and transient techniques. The Na impurity is injected into the LiF by plating NaCl on one surface of the LiF and placing a potential across the crystal at an elevated temperature. Large scale diffusion with Na dendrite formation is observable in a d-c arrangement and the diffusion can be measured by either radioactive tracer methods or measurement of charge transport. Transient experiments yield an activation energy for diffusion of approximately 0.3 ev for both edge and screw dislocations, and $D_0 = 0.01$ cm^2/sec. Analysis of the charge effects in the core of the dislocations leads to the proposal of a very large vacancy density in the core, and the experiments are even best understood in terms of a hollow of atomic dimensions along the dislocation core. (auth)

37595 STUDY OF THE LATTICE DEFECTS IN NORMAL AND NEUTRON IRRADIATED LITHIUM FLUORIDE BY DIELECTRIC RELAXATION MEASUREMENTS. H. Curien, J. Petiau, J. Fructus-Ricquebourg, and C. Petitjean (Faculté des Sciences, Paris). J. Phys. Soc. Japan, 18: Suppl. III, 133-5(Mar. 1963).

Carefully annealed LiF crystals do not show any dielectric relaxation phenomena between 0 and 100°C for frequencies between 10^2 and 10^5 c/s. After heating and quenching, divalent impurities associated with Li vacancies give a Debye domain of losses. The effects on the dielectric properties of neutron irradiation at the reactor temperature is a complete inhibition of divalent impurities and creation of dipolar defects revealed by two domains of losses; the mobile part of the dipoles giving one of these domains is Li vacancies. The point defects created by low temperature irradiation are essentially different. (auth)

37596 APPLICATION OF PRECIPITATION TECHNIQUES TO THE STUDY OF DEFECTS IN GERMANIUM. R. Weltzin and R. A. Swalin (Univ. of Minnesota, Minneapolis). J. Phys. Soc. Japan, 18: Suppl. III, 136-41(Mar. 1963).

The role of oxygen content, gamma-ray bombardment, annealing temperature, and solute concentration in the nucleation of lithium precipitates in germanium was investigated. Analysis of the experimental data indicates that the primary nucleation site for lithium precipitation is an oxygen-vacancy defect pair. The evidence indicates that about 1% of the oxygen exists in this particular paired state. For the reaction $O + V = O - V$ it was determined that the binding enthalpy of the pair is –0.6 ev and the concentration of O – V defects is given by $[O - V] = 2.6 \times 10^4 [O] \exp[-(1.4/kT)]$. Lithium was also found to exist in the paired state with interstitial oxygen although the complexes apparently are not active as nucleating sites. At room temperature about 25% of the interstitial oxygen atoms are paired according to the reaction $Li^+ + O = Li^+O$. The heat of binding of the pair was calculated to be about –0.5 ev. (auth)

37597 RADIATION PRODUCTION AND RADIATION ANNEALING OF POINT DEFECTS IN METALS. J. A. Brinkman (Atomics International, Canoga Park, Calif.). J. Phys. Soc. Japan, 18: Suppl. III, 150-7(Mar. 1963).

Radiation annealing affects damage curves in at least three ways: instantaneous recovery of interstitial-vacancy pairs within clusters lowers the slope relative to non-clustered damage; thermal and displacement spikes remove pre-existing interstitial-vacancy pairs, thereby introducing a curvature in the damage curves; and thermal spikes add to the specimen temperature, giving rise to anomalously large dependences of damage rates on specimen temperature. Some possible mechanistic interpretations of these phenomena are discussed and an attempt is made to indicate appropriate ranges of validity for each in terms of kind of irradiation and atomic number of the material. It was concluded that for $Z \gtrsim 25$ displacement spike effects generally dominate thermal spike effects for heavy particle irradiation. This interpretation is shown to be consistent both with theoretical mean free path concepts and with a number of experimental observations involving wide ranges of primary particles and atomic number. (auth)

37598 IRRADIATION-INDUCED ANNEALING OF STACKING-FAULT TETRAHEDRA IN GOLD. R. M. J. Cotterill and M. W. Jones (Cavendish Lab., Cambridge,

Eng.). J. Phys. Soc. Japan, 18: Suppl. III, 158-9(Mar. 1963).

The results of experiments in which radioinduced interstitials were used to initiate breakup in gold are reported. The irradiation temperature, below 50°C, was too low for vacancy emission, so the entire process was due to interstitial absorption. The results suggest that the interstitials generated during irradiation migrate to the tetrahedra and gradually annihilate them. The radioinduced vacancies, being less mobile, remain localized near their point of production and cluster to produce the black spot defects. (P.C.H.)

37599 DEFECT CONFIGURATIONS IN HEAVY-ATOM BOMBARDED BeO. J. R. Beeler, Jr. and D. G. Besco (General Electric Co., Cincinnati). J. Phys. Soc. Japan, 18: Suppl. III, 159-64(Mar. 1963).

Collision cascade calculations for krypton and iodine bombardment of BeO (wurtzite structure) were made using the hard-sphere scattering model. A Bohr screened potential was used to determine the distance of closest approach. Bombardment energies in the range 0.5–50 kev were considered. A significant part of both primary and ejected atom trajectories was restricted either to tunnels defined by successive hexagonal atom rings or to a region between two adjacent parallel atom planes. In these instances the stopping power was relatively small and the penetration anomalously large. The number of stable displacements in a cascade was found to be 31 and 35% of the number of displaced atoms given by the Seitz-Harrison and Kinchin-Pease models, respectively. The number of replacement collisions increased linearly with bombardment energy. The displaced atom energy spectra terminated below the hard-sphere collision threshold energy for each atom type. (auth)

37600 COLLISION PROCESSES IN ION IRRADIATION AND SPUTTERING DEPOSIT PATTERNS IN ZINC AND GERMANIUM. R. R. Hasiguti, R. Hanada, and S. Yamaguchi (Tokyo Univ. and Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Japan, 18: Suppl. III, 164-8 (Mar. 1963).

Sputtering deposit patterns from various planes of single crystals of zinc and germanium were observed. The patterns cannot be explained by the focusing collision chains in usual sense. Tentative explanations for the patterns are proposed. (auth)

37601 A DIRECT MEASUREMENT OF THE SIZE OF TEMPERATURE SPIKES PRODUCED BY FAST NEUTRON IRRADIATION. G. R. Piercy (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Phys. Soc. Japan, 18: Suppl. III, 169-79(Mar. 1963).

The size of temperature spike was measured directly by measuring the size of magnetic disordered regions produced by a fission neutron irradiation of non-magnetic ordered Pt_3Fe. The six irradiations from 3.4×10^{17} to 6.4×10^{19} fission n/cm^2 disordered between 1.2 and 86% of the sample volume. From the superparamagnetic behavior of the small isolated magnetic regions produced by irradiation below 4.4×10^{18} n/cm^2, it was concluded that each neutron collision produced an average of 2.3 temperature spikes with 3300 disordered atoms in each spike. The localized regions comprised a central core of complete disorder surrounded by a periphery of partial disorder. Within the validity of the Arrhenius equation at temperatures as high as 15000°K, the observed disordering could be explained by thermally activated diffusion within a temperature spike of 8.6 kev energy that is initially spread uniformly over a spherical volume of radius about 20 Å. (auth)

37602 X-RAY DIFFRACTION STUDIES OF DEFECT STRUCTURES IN IRRADIATED METALS. W. V. Cummings (General Electric Co., Pleasanton, Calif.). J. Phys. Soc. Japan, 18: Suppl. III, 189-94(Mar. 1963).

Lattice defects produced in molybdenum by neutron irradiation were studied by x-ray diffraction. An analysis of the line profiles show that fragmentation effects saturate at an exposure of 5.0×10^{19} neutrons per cm^2 and a minimum crystallite size of 500–600 Å is reached. The lattice parameter also reached a maximum at this point. The lattice microstrains, however, continue to increase with exposure in an isotropic manner. (auth)

37603 THE DIRECT OBSERVATION OF RADIATION DAMAGE IN PLATINUM. E. Ruedl and S. Amelinckx (Department Fysika Vaste Stof Studiecentrum voor Kernenergie, Mol, Belg.). J. Phys. Soc. Japan, 18: Suppl. III, 195-209(Mar. 1963).

Thin foils of platinum were examined by means of transmission electron microscopy. Annealed foils showed features typical for a face-centered cubic metal with a medium-high stacking fault energy. Prismatic loops with an a/2 [110] Burgers vector resulted from irradiation; this was found by observing their motion. The loops anneal out at about 500°C. Preferential loop formation was noticed at certain boundaries, in particular along coherent twin boundaries. This was considered as evidence for correlated collision chains leading to preferential defect formation at these boundaries. For small doses, dislocation loops were not distributed at random in the interior of the grains but showed a tendency to align. This was interpreted as resulting from loop nucleation along the path of a fission fragment. The damage rate of quenched specimens seemed to be larger than that of annealed ones; the loop concentration was less along a zone parallel to boundaries and subboundaries. It is suggested that either the vacancy clusters left by quenching are nucleation sites for loops, or that the vacancy clusters defocus collision chains and hence increase the damage. It is shown that as well vacancy as interstitial loops are left after fission-fragment and particle irradiation at liquid-nitrogen temperature. The loop character was determined by means of contrast effects. It was concluded that geometrical factors are important in determining the distribution of damage and that loop nucleation is heterogeneous and rate-dependent. (auth)

37604 OBSERVATIONS OF FISSION FRAGMENT DAMAGE IN SOME CRYSTALS. Kazuhiko Izui and Hideji Suzuki (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 18: Suppl. III, 210-15(Mar. 1963).

Electron microscopic observations were carried out on fission fragment-irradiated crystals such as molybdenum oxide, germanium, copper–aluminum alloy, and aluminum–copper–uranium alloy. Tracks of fission fragments were observed in molybdenum oxide but none in the other crystals. A number of small defect regions were observed as dark spots in germanium and as dark and light spots or sometimes loops in copper–aluminum alloy. The densities of the defect regions increased with increasing dose of fission fragments passing through the crystals. None of them was observed in aluminum–copper–uranium alloy. It was concluded that the track registrations in molybdenum oxide are a result of the evaporation due to the energy dissipated in electron excitations by fission fragments and that small defect regions in germanium and copper–aluminum alloy are displacement spikes due to the nuclear collisions. Separations of the defect regions are discussed in terms of the calculated mean free path for Rutherford collisions. The natures of displacement spikes are also discussed. (auth)

37605 PRODUCTION AND ALTERATION OF DEFECTS INDUCED BY ELECTRON IRRADIATION OF GERMANIUM. E. E. Klontz and J. W. MacKay (Purdue Univ., Lafayette, Ind.). J. Phys. Soc. Japan, 18: Suppl. III, 216-21(Mar. 1963).

Identification was made of three types of defects produced by 1.1 Mev electron irradiation of Ge at liquid helium temperatures. A primary defect, which anneals at 65°K, is responsible for initial damage, and permanent centers are formed from the primary defects. A secondary defect, which anneals at 35°K, is radioinduced from the permanent centers. Representation of the primary displacement as a metastable configuration of a vacancy-interstitial pair is the basis for discussion of a model explaining the results. An electron trapped on a defect increases the barrier to recombination thus providing for low temperature stability. Negligible production of damage in p-type material at low temperatures and the increased rate of introduction of defects in n-type material with increasing intensity of irradiation can be accounted for on the basis of the model. (auth)

37606 IRRADIATION AND ANNEALING BEHAVIOR OF n-TYPE GERMANIUM AND n-TYPE SILICON. E. G. Wikner, H. Horiye, and J. W. Harrity (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Phys. Soc. Japan, 18: Suppl. III, 222-5(Mar. 1963).

Studies were made on the radioinduced changes in the conductivity and Hall coefficient of n-type germanium and n-type silicon. The irradiations were performed at 80°K using 5, 15, and 45-Mev electrons. The number of defects formed, as measured by the observed carrier removal rates, depend logarithmically on the irradiation energy as predicted by the Seitz-Koehler model. Strong annealing processes were found to occur between 80 and 350°K. The processes were distinct from annealing occurring after lower energy irradiations. The annealing processes also depended on the amount of irradiation the sample receives. Studies were also made on the effects of the electron bombardment rate at 30 Mev. None was observed initially although longer irradiations exhibited some differences. (auth)

37607 INHOMOGENEITIES IN SEMICONDUCTORS EXPOSED TO FAST NEUTRONS. B. R. Gossick (Arizona State Univ., Tempe). J. Phys. Soc. Japan, 18: Suppl. III, 226-9(Mar. 1963).

The permittivity and conductivity were determined for a semiconducting sol of spheroidal inhomogeneities, with the symmetry axes oriented at random, the sols being those that might be induced by fast neutrons, such as p-type particles in n-type material, a dispersion of metallic precipitates, or ring dislocations. The presence of the localized inhomogeneities in a semiconductor would significantly alter its electrical properties. Both the displacement of majority carriers and minority carrier storage about the inhomogeneities would contribute to the permittivity. The potential barriers, which might accompany the inhomogeneities, would not only reduce the conductivity of majority carriers, but simultaneously increase the conductivity of minority carriers. (auth)

37608 ON DEFECTS INTRODUCED INTO SILICON BY FAST ELECTRON AND NEUTRON IRRADIATION. V. S. Vavilov and A. F. Plotnikov (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 18: Suppl. III, 230-6(Mar. 1963).

Photoconductivity measurements on Si single crystals irradiated by electrons and neutrons showed that the deep energy levels system in both cases is similar. Centers with deep levels were generated as a result of a primary process, presumably Frenkel pairs generation, and subsequent point defects migration. New energy levels not resolved by other methods were also observed. (auth)

37609 ON DEFECTS INTRODUCED BY FAST ELECTRONS INTO SILICON DOPED BY LITHIUM. V. S. Vavilov (Lebedev Inst. of Physics, Moscow), V. A. Chapnin, and I. V. Smirnova. J. Phys. Soc. Japan, 18: Suppl. III, 236-40(Mar. 1963).

The irradiation of lithium doped silicon by fast electrons led to the interaction of lithium with radioinduced defects. The introduction rates and stability of radioinduced centers with deep energy levels were considerably influenced. However, the most abundant deep energy levels did not shift. (auth)

37610 RADIATION DAMAGE AND ANNEALING OF CARRIER LIFE-TIME IN SILICON. Y. Inuishi and K. Matsuura (Osaka Univ.). J. Phys. Soc. Japan, 18: Suppl. III, 240-5(Mar. 1963).

Radiation damage (γ, neutron) and its annealing processes in various kind of Si crystals were investigated by measuring the change in minority carrier lifetime with microwave method. The interaction between radioinduced Frenkel defects and various other imperfections such as impurities (O, Ni, Au) and dislocations were found both in introduction and in annealing curves. Reverse annealing in pulled Si was ascribed to the formation and dissociation of vacancy-oxygen complex (A center). A similar effect occurred in Ni doped Si. Activation energy of the annealing was 1.2 ev for 0.7–0.8 ev for bulk and dislocation enhanced annihilation respectively. The depth of the recombination and trap levels were estimated from temperature dependence of life time, thermal release time, and Hall coefficient. (auth)

37611 ANNEALING OF RADIATION DEFECTS IN SILICON SINGLE CRYSTALS. H. Saito (Osaka Univ.), M. Hirata, and T. Horiuchi. J. Phys. Soc. Japan, 18: Suppl. III, 246-50(Mar. 1963).

N-type floating zone silicon single crystals containing phosphorus were irradiated with Co^{60} gamma rays at room temperature or bombarded with electrons of 2 Mev. Resistivity and Hall coefficient were measured as a function of temperature before and after irradiation. The results indicate the existence of two net acceptor levels, 0.17 and 0.4 ev below the conduction band respectively. The introduction rate of the deep level increased with increasing phosphorus concentration. Activation energy associated with the annealing of this level was found to be 0.94 ev in a temperature range of 120–180°C. On the other hand the introduction rate for the shallow level was independent of impurity concentration and this level was stable in this temperature range. Temperature dependence of Hall coefficient and Hall mobility after annealing suggest that a change has occurred in the nature of charge scattering center. (auth)

37612 RADIATION ENHANCED DIFFUSION IN SILICON. J. C. Pfister and P. Baruch (Faculté des Sciences, Paris). J. Phys. Soc. Japan, 18: Suppl. III, 251-4(Mar. 1963).

Silicon samples, with a prediffused impurity layer, were irradiated between 800 and 1200°C, by energetic protons (250 kev to 1 Mev). After irradiation it was found that the impurity had diffused much faster than expected from thermal diffusion. The increase in diffusion coefficient took place at some distance of the end point of the proton range, typically 2 to 5 microns. This result is consistent

with a model of point defect diffusion, where defects (vacancies or aggregates) created by irradiation diffuse in the bulk of the sample. It was thus possible to measure diffusion coefficients of the defects. Activation energy for motion near 1.2 ev and jump frequency of 10^7 sec^{-1}, at 850°C, was obtained. These values could be attributed to a divacancy. The annihilation mechanism was investigated, and is shown to depend on grown-in dislocation density. (auth)

37613 POINT DEFECTS, AND THE NATURE OF RADIATION DAMAGE IN F.C.C. METALS. A. Seeger (Technische Hochschule, Stuttgart). J. Phys. Soc. Japan, 18: Suppl. III, 260-6(Mar. 1963).

The recovery of electron bombarded gold and copper, and the relation to the migration energies of point defects are discussed. It is shown that the basic recovery spectrum of gold is very simple, consisting of a series of close interstitial-vacancy pair (Stage I), a background due to the migration of interstitials to nearby vacancies (Stage II), and the free migration of interstitials (Stage III, migration energy 0.71 ev). This interpretation agrees fully with quenching and cold-work data. In copper there is also close-pair substages and a free migration stage (I_E) due to recombination of metastable crowdions with vacancies. The concentration dependence of I_E is fully accounted for by this picture. An analysis of the experimental data indicates that in copper the threshold energy for crowdion formation is about 25 ev, whereas the absolute threshold (in (100)) is about 15 ev. (auth)

37614 RADIATION EFFECTS IN METALS AT LOW TEMPERATURES. A. Sosin (Atomics International, Canoga Park, Calif.). J. Phys. Soc. Japan, 18: Suppl. III, 277-83(Mar. 1963).

An extensive study was made of the radiation damage by electrons and post irradiation annealing in pure and alloyed copper and aluminum. Copper + 0.1 at. % silver and beryllium and copper + 0.03, 0.1, 0.3, and 1.0 at. % gold were investigated. The recovery data are reasonably consistent with a model due to Hasiguti and Martin. Aluminum + 0.1 at. % copper and zinc also have received attention, but some discrepancy is noted. A qualitative model, invoking migration and trapping of crowdions, appears to fit the recovery data. Stage III in aluminum is governed by second-order kinetics with an activation energy of 0.45 ev. Thus copper and aluminum possess the same Stage III dilemma. (P.C.H.)

37615 VOLUME CHANGES INDUCED BY RADIATION IN COPPER AND ALUMINUM. T. H. Blewitt (Argonne National Lab., Ill.), R. R. Coltman, and C. S. Klabunde. J. Phys. Soc. Japan, 18: Suppl. III, 283-7(Mar. 1963).

The volume change associated with low-temperature reactor bombardments were studied for Al and Cu. In each of the cases the volume change-dose relationship was determined as well as isochronal annealing curves. The specific change in length (strain) $\Delta l/l$ for copper was found to be 6×10^{-5} cm/cm corresponding to a change in resistivity of 5.2×10^{-9} ohm cm. A ratio of 1.25×10^{-3} was found for the resistivity change. The isochronal annealing studies imply that if interstitials are moving during Stage II then vacancies must be moving in Stage III. For Al the ratio of length change to resistivity change is given by 1.23×10^3 ohm cm^{-1}. The corresponding strain is 3.5×10^{-4}. It is noted that the isochronal recovery curves for uranium doped Al are identical to those of pure Al. (P.C.H.)

37616 ENERGY RELEASE IN IRRADIATED COPPER. T. H. Blewitt (Argonne National Lab., Ill.), R. R. Coltman, and C. S. Klabunde. J. Phys. Soc. Japan, 18: Suppl. III, 288-92(Mar. 1963). (TID-15886; UAC-6367)

Energy release measurements associated with Stage I recovery of reactor-irradiated Cu are reported. The resistivity associated with the release of the stored energy was also measured. A decrease in resistivity is used as a criterion for the amount of damage introduced into the sample. The experiment shows that an energy release of 4.54 cal/mol will be associated with a recovery of 1.77×10^{-2} $\mu\Omega$ cm. Thus,

$$\frac{E}{\Delta\rho} = \frac{4.54}{1.77 \times 10^{-2}} \frac{2.56 \text{ cal/mole}}{\mu\Omega \text{ cm}} = \frac{4.01 \text{ cal/g}}{\mu\Omega \text{ cm}}.$$

(P.C.H.)

37617 RECOVERY STAGES IN NOBLE METALS. W. Schuele (C. C. R. Euratom, Ispra, Italy). J. Phys. Soc. Japan, 18: Suppl. III, 292-8(Mar. 1963).

Recovery processes occurring in the temperature range of stage III and IV after irradiation, deformation, and quenching of Cu, Au, and Ag are discussed. A comparison of the activation energies measured in this temperature range and a consideration of the kinetics during recovery suggest the migration of interstitials in stage III and the migration of vacancies in stage IV. (auth)

37618 DIVACANCIES IN IRRADIATED COPPER. H. Suzuki (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 18: Suppl. III, 299-304(Mar. 1963).

Divacancy migration was ascribed to stage III of recovery process on the basis of the observation on serrations and the bump in the stress-strain curve of low temperature irradiated copper crystal. The divacancies may be produced as the direct results of irradiation. The processes of divacancy formation are discussed referring to a calculation previously performed. Although the chance of divacancy formation depends on the direction of initial motion of the knock-on, sufficiently large probability is expected even in the irradiation by 1 Mev electrons. (auth)

37619 THE MIGRATION OF LARGE CLUSTERS OF POINT DEFECTS IN IRRADIATED MATERIALS. R. S. Barnes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phys. Soc. Japan, 18: Suppl. III, 305-11 (Mar. 1963).

Experiments on Al, Cu, and graphite irradiated with fission fragments, alpha particles, or neutrons show that the migration of dislocation loops, formed from large clusters of point defects, can be important in determining the size, configuration, and distribution of the clusters. The direction of migration, and magnitude of the driving force, is determined largely by the elastic stresses due to other nearby clusters (but also by internal stress fields induced by free surfaces, and grain boundaries. The migration distances depend also upon the relative ease of the two migration processes, slip and climb. There are instances where neither process occurs and instances where one predominates over the other. Many factors determine the relative importance of slip and climb, but the crystallographic form of the cluster is vital. (P.C.H.)

37620 ACCUMULATION OF SELF-DAMAGE IN PLUTONIUM. J. A. Lee (Atomic Energy Research Establishment, Harwell, Berks, Eng.), K. Mendelssohn, and D. A. Wigley. J. Phys. Soc. Japan, 18: Suppl. III, 312-14(Mar. 1963).

In plutonium metal radioactivity leads at low temperatures to a gradual increase of electrical resistivity with time. This accumulation of self-damage was studied in an experiment lasting 5000 hours. The results of damage and subsequent annealing are described. An explanation of the

results is that radiation destroys the long range order, and that after 5000 hr there is little trace left of it. (P.C.H.)

37621 THE INTERACTION BETWEEN IRRADIATION-INDUCED DEFECTS AND MAGNETIC STRUCTURE. A. I. Schindler (Naval Research Lab., Washington, D. C.), and R. H. Kernohan. J. Phys. Soc. Japan, 18: Suppl. III, 314-20 (Mar. 1963).

Hysteresis loop measurements were conducted on several commercial iron-nickel alloys during neutron irradiation at 90°K and ambient reactor temperature in both zero and saturating magnetic field. Isochronal annealing tests were also performed on the alloys after irradiation. The low temperature irradiation results indicated that magnetic properties were affected not by the point defects themselves but by their motion and eventual disposition. The radioinduced changes appeared similar to those observed in the alloys upon magnetic annealing, namely, short-range atomic ordering. However, in all cases the radioinduced changes were annealed out at temperatures below the usual ordering temperature. The recovery process appeared to be dependent upon the state of magnetization of the sample. (auth)

37622 POINT DEFECT FORMATION IN ALKALI HALIDES. B. S. H. Royce (Princeton Univ., N. J.), J. Sharma, R. Smoluchowski, and R. N. Euwema. J. Phys. Soc. Japan, 18: Suppl. III, 321-5(Mar. 1963).

The essential features of defect formation in a perfect lattice by ionizing radiation are the multiple ionization and the mechanism of displacement of a halogen to an interstitial position far from the vacancy. In this connection the role of the Auger process, the possibility of M-center formation, and the tunnelling process that affects the probability of an electron capture by a vacancy are discussed. (auth)

37623 RADIATION EFFECTS IN ALKALI HALIDES AT LOW TEMPERATURES. C. C. Klick, V. H. Ritz, and D. A. Patterson (Naval Research Lab., Washington, D. C.). J. Phys. Soc. Japan, 18: Suppl. III, 326-8(Mar. 1963).

When KBr and KCl are x rayed at liquid helium temperatures two large bands, the α- and γ-bands, are formed. The bands are much larger than F and H bands. It is suggested that the α- and γ-bands arise from an interstitial halide ion and halide ion vacancy, which have not separated far, and that the F and H bands arise from the same defects separated by 10 lattice spacings or more. Coloration efficiencies for various alkali halides were measured under 2 Mev electron radiation and with x rays of differing quality. A significant variation of efficiency with type of radiation was found. Analysis of the variation suggested that F-centers do not arise primarily from single ionizations nor from Auger processes in the kinds of radiation employed. (auth)

37624 INVESTIGATIONS OF COLOR CENTERS IN ALKALI HALIDES AT OAK RIDGE NATIONAL LABORATORY: STRUCTURE SENSITIVITY OF COLOR CENTER PRODUCTION IN γ-IRRADIATED KCl. J. H. Crawford, Jr. (Oak Ridge National Lab., Tenn.). J. Phys. Soc. Japan, 18: Suppl. III, 329-33(Mar. 1963).

Investigations of the structure sensitivity of color center formation in γ irradiated KCl are reviewed. Both Stage I and Stage II coloration ranges are sensitive to the origin of the crystals studied. The presence of divalent cation (M^{2+}) markedly enhances Stage I and suppresses Stage II relative to nominally pure crystals. The enhancement in Stage I can be explained by a model involving the conversion of an isolated cation vacancy into an F-center and a $[Cl_3^-]$ ion by a radiolytic reaction. Mechanisms by which M^{2+} might suppress Stage II coloration were explored. These are: suppression of the concentration of electrons and holes produced by the radiation field by acting as electron-hole recombination centers; poisoning dislocations as a source of lattice defects; and alteration of the nature of quenched-in defects. None of these possibilities is wholly satisfactory to explain experimental observations. (auth)

37625 X-RAY GENERATION OF M CENTERS IN ALKALI HALIDES. Herbert Rabin (Naval Research Lab., Washington, D. C.). J. Phys. Soc. Japan, 18: Suppl. III, 334-9(Mar. 1963).

Recent studies of the M center point to the F_2 model as the appropriate model of this center. A discussion is given of a number of points relating to M-center formation at room and low temperatures as well as of the M-center oscillator strength based on low temperature x irradiation. (auth)

37626 LOW TEMPERATURE BLEACHING OF F CENTERS IN IRRADIATED ALKALI HALIDES. N. Itoh and T. Suita (Osaka Univ.). J. Phys. Japan, 18: Suppl. III, 340-4(Mar. 1963).

The recovery of F centers after bleaching at liquid nitrogen temperature was studied in KCl and NaCl γ irradiated with various doses. The study of the effect of bleaching temperature and bleaching time on the recovery curves showed that the bleaching and recovery at liquid nitrogen temperature were due to the transfer of electrons from the excited state of F centers and from F′ centers respectively without ionization. The recovery curves are also shown to be expressed by the summation of several exponentials. In KCl the recovery with the time constant of $2 \sim 4$ min was most prominent for lower doses, whereas for higher doses the recovery appeared with the time constant higher than 50 min. It was concluded that there are two types of localization of F centers. The first type of localization seems to occur when vacancies are formed by radiation interacting with a point defect. The second type localization seems to arise from vacancies formed at dislocations, so that it can be observed only at higher doses. F centers in the first localization seem to be converted to colloids as the radiation dose increases. When the irradiation temperature was low, only the second type of localization was observed, the time constant for which was smaller. (auth)

37627 DIRECT OBSERVATION OF CRYSTAL IMPERFECTIONS IN KCl SINGLE CRYSTAL DUE TO ELECTRON AND X-RAY IRRADIATION. T. Hibi, K. Yada, and Y. Kawamata (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 18: Suppl. III, 345-9(Mar. 1963).

Electron microscope observations were made of crystal imperfections caused by electron and x irradiation in thin KCl single crystals made by three different methods. In KCl crystal made from its water solution, loop structures appeared and disappeared and then small cubic cavities appeared under weak electron irradiation, while large cubic cavities appeared directly under intense electron irradiation. In KCl crystal made by electrolytic etching, parallel pair dislocation lines always appeared besides loop structures and then disappeared under weak electron irradiation, while small bright specks appeared under intense electron irradiation. In KCl crystal made by water etching, dislocation loops first appeared and then loop structures appeared and then disappeared under weak and also intense electron irradiation. In x irradiated KCl crystal made from water solution, loop structures and dislocation lines appeared and then disappeared, while large cavities were rarely observed under intense x irradiation. The mechanism of coagulation of vacancies is discussed. (auth)

37628 ELECTRON MICROSCOPIC STUDY OF AGGREGATION OF POINT DEFECTS IN KCl. K. Tanaka, M. Mannami, and K. Izumi (Kyoto Univ.). J. Phys. Soc. Japan, 18: Suppl. III, 350-5(Mar. 1963).

Thin foils of KCl were prepared by chemical polishing for the electron microscope. The formation of lattice defects, namely, thin voids parallel to one of the {100} planes of KCl and dislocations in the foils by electron irradiation during the observation were studied. Temperature dependence of the process of lattice defects formation was also examined. (auth)

37629 ON ELECTRON MICROSCOPY OF SODIUM AND POTASSIUM CHLORIDE FILMS. G. Honjo and K. Yagi (Tokyo Inst. of Tech.). J. Phys. Soc. Japan, 18: Suppl. III, 355-6(Mar. 1963).

A method is reported for the preparation of clean, thin single-crystal films of NaCl and KCl. The method is to irradiate the films rather strongly by electron beam. Then parts of the surface layer of the films scale off leaving thin areas of several microns square, or even wider. Thin areas so produced are free from specks and tangled strings and fairly stable under further electron irradiation. The fact that specks and tangled strings vanish when surface layers scale off suggests that they are in the surface layers. (P.C.H.)

37630 THE COLOR CENTERS IN LITHIUM FLUORIDE. J. V. R. Kaufman (Picatinny Arsenal, Dover, N. J.) and C. D. Clark. J. Phys. Soc. Japan, 18: Suppl. III, 357-60 (Mar. 1963).

Measurements are reported of the optical absorption induced by electron irradiation at 120 and 293°K, the effects on the induced absorption resulting from thermal annealing experiments, the anisotropy of the absorption bands that is observed after optical bleaching with plane polarized light, and the absorption of LiF crystals subjected to additive coloring treatments. Anisotropic absorption was induced in the 4500Å (2.76 ev) band by plane polarized light. Results indicate that at least two bands constitute the 4500Å band, and that they are closely related to one another. One of these bands may be associated with M centers. Only in one crystal, subjected to additive coloring with Mg, was a change in the absorption spectrum observed. The added absorption did not show a 2500Å (4.958 ev) band, which has been associated with the F center. Moreover in low temperature low dose electron irradiations a 2500Å band was barely detected immediately after irradiation but increased in strength on standing. The results show that analogies between results on LiF and the other alkali halides cannot be carried too far. (auth)

37631 COMPARISON BETWEEN THE EFFECTS OF NEUTRON IRRADIATION AT- 195°C AND AT 100°C ON LiF CRYSTALS. M. Lambert, S. Lefebvre, and A. Guinier (Faculté des Sciences, Orsay, France). J. Phys. Soc. Japan, 18: Suppl. III, 361-3(Mar. 1963).

The nature of defects formed by neutron irradiation under liquid nitrogen of lithium fluoride crystals was investigated by means of x-ray experiments. Complex defects were formed: they could have been produced either directly by the bombarding particles or by clustering of point defects. The number of complex defects (but not their nature) is a function of the neutron dose as indicated by preliminary experiments. The influence of further annealing was also studied: cavities were observed that resemble those present in crystals irradiated at 100°C. (auth)

37632 ELECTRICAL CONDUCTIVITY OF IRRADIATED LiF. P. Perio (Universite, Paris), M. Dubois, P. Berge, and G. Blanc. J. Phys. Soc. Japan, 18: Suppl. III, 363-7 (Mar. 1963).

By neutron irradiation of samples of widely different impurity content, discrimination was made between effects on the impurity complexes and on the LiF matrix proper itself. Furthermore, the control of temperature of irradiation gave some insight on the defect generation itself. It was concluded that really pure samples, by contrast with impurity compensated samples, are needed before a better and quantitative description of the phenomenon can be obtained. (P.C.H.)

37633 RADIATION EFFECTS IN α-QUARTZ. G. S. Zhdanov, V. G. Zubov, E. V. Kolontsova, L. P. Osipova, and I. V. Telegina (Moscow State Univ.). Soviet Phys.-Cryst. (English Transl.), 8: 154-8(Sept.-Oct. 1963).

A comparison was made between Raman spectra of α-quartz before and after neutron irradiation, and structural characteristics determined from Laue and anomalous scattering x-ray patterns, using the same single crystal. A model was devised for the structural changes occurring in quartz on neutron irradiation. (auth)

37634 THE EFFECT OF SPIN-SPIN INTERACTION ON THE SCATTERING OF SLOW NEUTRONS IN FERRITES. V. N. Kashcheev (Inst. of Physics, Riga). Soviet Phys.-Solid State (English Transl.), 5: 635-40(Sept. 1963).

The attenuations and frequency shifts of magnons, which are caused by spin-spin interactions in ferrites were calculated. The quantities were obtained as functions of the magnon wave vector, temperature, and intensity of the external magnetic field. (auth)

37635 EFFECT OF THE SPIN-PHONON INTERACTION ON ONE-QUANTUM SCATTERING OF SLOW NEUTRONS IN FERRITES. V. N. Kashcheev (Inst. of Physics, Riga). Soviet Phys.-Solid State (English Transl.), 5: 668-75(Sept. 1963).

Contributions to the damping and frequency of magnons and phonons due to the spin-phonon interaction in isotropic ferrites were calculated. The dependence of the quantities on wave vectors of elementary excitations, temperature, and external magnetic field was also calculated. Analysis of the quantities for acoustic phonons was carried out for any law of dispersion of the latter for those directions in the reciprocal lattice for which vibrations separate into longitudinal and transverse. (auth)

37636 RADIATION EFFECTS ON ELECTRICAL INSULATION FOR COMPACT REACTORS IN SPACE. J. W. Ramsey and M. Warren (Atomics International, Canoga Park, Calif.). New York, Institute of Electrical and Electronic Engineers, 1963, Preprint Paper CP63-1182, 14p. (CONF-1-24)

From Institute of Electrical and Electronics Engineers 1963 Summer Meeting, Toronto, June 1963.

Radiation experiments were conducted on high-temperature electrical encapsulants and electrical connectors in order to evaluate their performance for use in the unique combined environment of reactor, radiation, high temperature, and vacuum to be found in the SNAP reactor operational environment during space flight. In general, the insulating cement and the connector insulations showed a decreasing insulation resistance with time when tested at 800°F and 10^{-6} Torr vacuum both in the reactor and out of the reactor. No gross effect of radiation appeared on the resistance of three insulation materials when tested at 800°F in a 10^{-6} Torr vacuum with radiation flux of 6.5×10^{12} nv neutrons (>0.1 Mev) and 2.7×10^{7} R/hr gamma. (P.C.H.)

37637 NEW RADIATION RESISTANT GREASES. Sharda DasGupta and J. T. Slobodian (Atomic Energy of Canada Ltd., Ottawa). 35p. (CONF-175-1)

From American Chemical Society 142nd National Meeting. Atlantic City, Sept. 1962.

New radiation resistant greases were prepared from commercially available greases by carrying out radioinduced reactions with styrene. The radiation tolerances of the products were 250-1000 fold more than the starting materials and any product of similar properties now available. The various properties of the new products initially and after exposure to large radiation doses were in no case inferior to the original greases and in some respects improvements were observed. Radiation tolerance of commercial greases could be enhanced by the addition of polystyrene to form a physical mixture rather than copolymers. The reaction mechanisms involved at all stages were studied using infrared spectroscopic techniques. (P.C.H.)

37638 ARTIFICIAL ELECTRON-BELT RADIATION PROTECTION FOR THE EXPLORER XVI SOLAR CELL POWER SUPPLY. John L. Patterson and William E. Miller (Langley Research Center, Hampton, Va.). New York, American Inst. of Aeronautics and Astronautics, 1963, Preprint 63-186, 11p, $1.00. (CONF-97-14)

From Summer Meeting, Los Angeles, June 1963.

The high-altitude nuclear explosion of July 9, 1962 caused a new artificial radiation belt, which posed an unanticipated radiation hazard to the solar cell power supply of Explorer XVI. Samples of the solar cells and prospective shielding materials were irradiated with 1.2-Mev electrons from the Langley Research Center electron accelerator in order to determine additional protection needed. It was concluded that $^{3}/_{16}$-in. quartz windows will protect the cells sufficiently that service lifetimes greater than one year may be obtained. Evidence was found that bremsstrahlung damage may be greater than previously estimated. Small differences in quartz made major differences in darkening under irradiation; however, samples of synthetic fused quartz obtained from several manufacturers did not perceptually darken in the spectral range of interest. (A.G.W.)

37639 CONTRIBUTION TO THE UNDERSTANDING OF THE WIGNER EFFECT ON GRAPHITE. Denis Martin and Jacques Bauzit. 28p. (CONF-73-12). (In French)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

The accumulation of Wigner energy in the G-1 reactor and the three anneals for its release are discussed. The anneal equipment is described before the history of the anneals is given. The anneal method used is based on the scheme of nuclear preheating, thermal shock, adiabatic insulation, and cooling. The safety limits during this procedure are defined, and the dimensional variations are discussed. Anneal has not yet been necessary in the G-2 and G-3 reactors, but the present conditions in those reactors are outlined. (J.S.R.)

PHYSICS

General and Miscellaneous

Refer also to abstract 37010.

37640 (AD-289801) EXPLORATORY ENERGY CONVERSION STUDY OF PHOTON THERMIONICS. Quarterly Technical Progress Report No. 1. W. T. Kearns (General Electric Co. Power Tube Dept., Schenectady, N. Y.). Nov. 1962. Contract AF33(657)-9202. 20p.

Theoretical considerations in the use of light of various wavelengths to enhance the output of a Cs vapor thermionic converter, or even to initiate the arc, were examined. Particularly, photon-gas interaction in the vapor that would increase plasma conductivity by ion pair production due to light energy absorption was considered. The use of the 3888 Å He line to excite the Cs vapor 8521 Å resonance line through resonance and cascade fluorescence phenomena appears to be the most promising approach. A preliminary design for an experimental tube to test the concept was devised. Some less promising approaches are discussed. (D.C.W.)

37641 (AD-290819) PROGRESS REPORT NO. 1 [ON CONDENSATION COLLOIDAL ION ENGINE]. June 1–August 13, 1962. (Ion Physics Corp., Burlington, Mass.). Sept. 17, 1962. Contract AF33(657)-8743. 74p.

Experimental studies of three types of ionizers were conducted. Ion extraction from the contained arc is difficult, so that only low currents and charge-to-mass ratios can be obtained with this type of source. The free arc and corona ionizers produce useful ion currents, but the investigation of these ionizers indicates a need for beam focusing and removal of electrons from the colloidal ion beam in the growth region. A new colloidal ion source was fabricated to study the effect of magnetic fields in the ionization region to accommodate propellant materials which require higher operating temperatures. This source will be operated in a new vacuum tank. A collector was fabricated to permit accurate evaluation of mass beam collimation. A quadrupole mass spectrometer was employed in some experiments, but no charge-to-mass ratio measurements were achieved with it yet. Hot wire anemometers were obtained to investigate a new technique for detecting the presence of colloidal material. Tables and graphs of flow data were prepared for use over the mass flux range of interest. Analysis of the nucleation process indicates that sodium vapor would form a considerable amount of uncharged colloidal material as well as the charged particles. Cadmium and mercury seem much more likely to undergo preferential ionic nucleation. (auth)

37642 (ARF-1214-TR-3) A NUCLEAR-PHOTON ENERGY CONVERSION STUDY. Quarterly Technical Report No. 3, October 1, 1962 to December 31, 1962. H. V. Watts and S. Nudelman (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Jan. 15, 1963. Contract AF33(657-8527. 29p. (AD-295003)

The temperature dependence and phosphor thickness dependence of the luminescence output was studied for several phosphors that appear promising for use in a nuclear-photon energy conversion system. In this system, beta particles from a radioisotope source are absorbed by the phosphor which emits a multiplicity of low energy photons. These photons are then converted to electrical energy by a photovoltaic device. The most promising phosphor to date, a ZnCdS:Cu, had about a 15% decrease in luminescence intensity as the temperature was increased from room temperature to 120°C, and was found to be relatively transparent to its own light with an optimum thickness for Sr^{90} beta excitation of 160 mg/sq cm. Sr^{90} beta particle radiation damage studies on this phosphor indicate an onset of damage at a total radiation dose of 10^8 ergs/sq cm. These data indicate that Sr^{90} cannot be used and that the maximum operating temperature is about 120°C. Calculations indicate that, with a maximum temperature of 120°C allowed in the device, a maximum power input density of 200 mw/cm^2 is permitted. (auth)

37643 (ASD-TDR-62-411(Pt.I)) ELECTRODELESS MHD GENERATOR RESEARCH. PART I. THEORETICAL ANALYSIS. J. B. Fanucci, L. J. Kijewski, G. F. Miller III, N. Sands, N. Ness, I. B. Bernstein, R. M. Kulsrud, J. E. McCune, D. duP. Donaldson, and W. D. Jackson (Radio Corp. of America, Missile and Surface Radar Div., Moorestown, N. J.). Mar. 1962. Contract AF33(616)-7913. 204p. (AD-291713)

The theoretical investigation encompassed both the electrodynamic and gas dynamic aspects of the a-c MHD generator and their relationship to each other. The following areas of investigation are included: generator impedance, side losses, fringing effects, channel flow, heat transfer, plasma viscosity, operating conditions, and starting transients. Parametric studies are included for several of the above-mentioned topics. The results of the above studies has led to the design of an experimental generator. The addition of a ferromagnetic material external to the generator improves the power factor characteristics. Power factors up to 0.4 are possible at low frequencies. Supersonic rather than subsonic operation of the generator yields the higher power densities. Fringing effects indicate the need for shading magnetic fields analogous to d-c generators. Heat protection of the a-c MHD generator walls by transpiration cooling is feasible. (auth)

37644 (BNL-6681) WAVE FUNCTIONS FOR QUADRUPOLE ANTISHIELDING FACTORS. R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.). Jan. 17, 1963. Contract AT-30-2-GEN-16. 13p.

Perturbed wave functions obtained in a calculation of the quadrupole antishielding factors γ_∞ for Mn^{+2}, Fe^{+3}, Ga^{+3}, and Ag^+ ions are tabulated. The functions represent the effect of the perturbation due to a nuclear quadrupole moment Q on the wave functions of the outermost electrons of the ion core. Their computation is also outlined. (auth)

37645 (DCAS-TDR-62-171) ENERGY CONVERSION PROGRAM—MAGNETOHYDRODYNAMIC GENERATOR. Semiannual Technical Report, January 1–June 30, 1962. W. R. Grabowsky and K. E. Starner (Aerospace Corp., El Segundo, Calif.). Aug. 31, 1962. Contract AF04(695)-69. 28p. (AD-291076; TDR-69(2220-40(TR-2)

Progress in the materials studies of interest in the design and study of a magnetohydrodynamic vortex generator for use in a closed-cycle power conversion system is described. Experimental results of tests to determine the tensile strength properties of tantalum to its melting point are presented. Measurements of temperature creep and

stress deformation definitely indicate that creep rate will rule out use of tantalum as the sole structural material at design stresses greater than 600 psi. Fabrication difficulties in the use of tungsten possibly may be overcome or alleviated by wire-wrapped construction. Design of an electron bombardment heated test facility to determine the electrical resistivity of high-temperature (2500°K) insulating materials is described. (auth)

37646 (KN-62-133(R)) LECTURES ON HEAVY PARTICLE INTERACTIONS, HELD AT KAMAN NUCLEAR COLORADO SPRINGS, COLORADO, JULY 2-18, 1962. Earl W. McDaniel, C. Y. Fan, Edgar Everhart, and M. R. C. McDowell—J. W. Bond, Jr., ed. (Kaman Aircraft Corp. Kaman Nuclear Div., Colorado Springs). Sept. 1, 1962. Contracts AF19(628)-209 and NOrd 18098. 190p. (AD-292078)

Experimental and theoretical information on interactions between neutral or ionized atomic systems at energies from a few Mev down to thermal is compiled. 115 references. (D.C.W.)

37647 (LADC-5695) AN IMMERSION SPECTROPHOTOMETRIC DETERMINATION OF THE OPTICAL CONSTANTS OF ANODIC OXIDE INTERFERENCE FILMS ON TANTALUM METAL. Walton P. Ellis (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 13p. (CONF-203-1)

From Colloquium on the Optics of Solid Thin Films, Marscielle, Sept. 1963.

Immersion of an in situ interference film into a liquid alters the optics by diminishing the amplitude of the wave vector reflected at the medium-film interface. With interference layers of anodic oxide on tantalum, immersion into liquids of progressively higher refractive indices decreases the degree of interference in a regular fashion. From an analysis of the spectrophotometrically determined interference peak heights, the refractive index of anodically formed tantalum oxide was obtained for different orders of interference in the wavelength range 4000 to 6100 Å. (auth)

37648 (LADC-5748) ANHARMONIC SPECIFIC HEAT AT INTERMEDIATE TEMPERATURES. W. C. Overton, Jr. (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 16p. (CONF-204-2)

From International Conference on Lattice Dynamics, Copenhagen, Denmark, Aug. 1963.

The thermodynamic properties of an anharmonic crystal can be approximately described at intermediate temperatures in terms of the "anharmonic deviation spectrum," $\Delta g(\nu,T)$ vs. $\nu = [G(\nu,T) - G_h(\nu)]$ vs. ν. For a reliable determination of Δg, an accurate harmonic vibration spectrum $G_h(\nu)$ vs. ν is required. From knowledge of the anharmonic frequency shifts $\Delta\nu(T)$'s and $G_h(\nu)$, one may obtain $\Delta g(\nu,T)$ by graphical analysis. Δg is found to be highly structured for ν near the frequencies of the Van Hove singularities. As an illustration the case of an fcc lattice approximately representative of copper is considered and $\Delta\nu$ is assumed = $A_i T$, with the A_i treated as parameters. The $\Delta\nu$ are assumed proportional to $\nu_h(\vec{k})$ throughout the Brillouin Zone. For small shifts the specific heat deviation $\Delta C/C_h$ (C_h = harmonic theoretical specific heat) is found to be approximately linear in T. For larger shifts, however, $\Delta C/C_h$ undergoes small amplitude anharmonic oscillations. The oscillatory character of these calculated results appears to be borne out by ample experimental evidence of small oscillations in the thermodynamic properties of several solids. (auth)

37649 (MIT-DSR-8535) THE USE OF AN ELECTROLYTE IN MODEL MHD POWER GENERATORS. Technical Report 37. Eugene E. Covert and Daniel T. Nowlan (Massachusetts Inst. of Tech., Cambridge. Aerophysics Lab.). May 1962. Contract AF40(638)-900. 18p. (AD-289688)

The problems associated with the use of electrolytes in scale models for tests of MHD generators are discussed. It is concluded that the Hartmann number and fluid Reynolds number must be matched between the model and the full-scale device. (auth)

37650 (NASA-TN-D-1879) THERMIONIC EMISSION FROM CESIUM-COATED ELECTROSTATIC ION-THRUSTER ELECTRODES. Thaine W. Reynolds and Edward A. Richley (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Sept. 1963. 33p.

An analysis indicates that electron-emission currents from a cesium-coated tungsten accelerator electrode in an ion thrustor can be as high as 4 percent of the ion-beam current when the only source of adsorbed cesium is direct neutral flow from the ion emitter. If neutral-cesium atoms accumulate in the interelectrode space, electron emission from the accelerator electrode may become 40 percent of the ion-beam current. Either cooling or heating of the accelerator electrode could reduce the electron current considerably. (auth)

37651 (NP-13101) THE DIFFUSION OF HYDROGEN AND OTHER LIGHT GASES THROUGH MEMBRANES, FOROUS MEDIA, AND THIN PLATES: AN ANNOTATED BIBLIOGRAPHY. Charlie M. Pierce, Comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Oct. 1962. 17p. (SB-63-26)

The diffusion of light gases through porous and semiporous materials has not been studied to any great degree and, unfortunately, very few references have appeared. This bibliography contains 30 selected references dating from 1932. (auth)

37652 (NYO-10691(Pt.1)) A SPECTROSCOPIC STUDY OF THE ALPHA RAY INDUCED LUMINESCENCE IN GASES. PART 1. P. Harteck, S. Dondes, and C. O. Kunz (Rensselaer Polytechnic Inst., Troy, N. Y.). Sept. 1963. Contract AT(30-3)-321. 116p.

A study was made of the emission spectra produced by the Po^{210} alpha irradiation of: He;He:N_2;N_2;N_2:O_2;N_2:NO at atmospheric pressure. Spectrograms were taken between 2,000 and 12,000Å, with and without the application of an electric field, and at −193, −186, or 25°C. Observations indicated that impurities played a major role in the results obtained. The predominant emission in He was the $N_2^+(^2\Sigma^+)$, when N_2 was present in concentrations less than 1%. Above 1% N_2, the strongest emission was the $N_2(C^3\pi_u \rightarrow B^3\pi_g)$. Energy transfer from the resonance levels of He to N_2 and subsequent N_2 interactions explain the observed emission spectra. In Ar, the predominant emissions are the $N_2(C^3\pi_u \rightarrow B^3\pi_g)$ bands and Ar lines. The N_2^+ emission is produced by energy transfer from Ar excited to its resonance levels. An electric field intensifies the N_2 $(C^3\pi_\mu \rightarrow B^3\pi_g)$ emission. In N_2, the spectra is similar to that obtained with an electric discharge. Oxygen impurities in concentrations of 0.1% produce the beta and gamma bands of NO in addition to the N_2 bands. When the concentration of O_2 is reduced to 0.01%, the forbidden OI transition ($^1S \rightarrow {}^1D$) at 5577Å is observed with an intensity exceeding any other system. The application of an electric field quenches this emission. Several possible ion mechanisms are proposed to explain this observation. The addition of small concentrations of NO to N_2 produced the NO beta and gamma bands, not from the direct excitation, but

from the three-body recombination of N,O and M (third body). (auth)

37653 (ORNL-3468) OPTICAL EMISSION FROM ELECTRON IRRADIATED THIN GOLD FOILS. D. C. Hammer, E. T. Arakawa, L. C. Emerson, and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Sept. 10, 1963. Contract W-7455-eng-26. 67p.

Thesis submitted by D.C.H. to University of Vanderbilt, Nashville.

The light produced in thin gold foils, 340 and 530 Å thick, by high-energy electron bombardment was investigated in the wavelength region between 2500 and 5500 Å. Monochromatic electron beams of 1.5 μa with energies between 25 and 100 kev were used in the study. The spectral distribution and the polarization characteristics of the light were determined with a Seya-Namioka vacuum ultraviolet spectrometer, Glan prism analyzer, and a 13-stage quartz window photomultiplier. The optical system was calibrated by use of a standard lamp obtained from the National Bureau of Standards. The experimental results show that gold emits a continuous distribution of photons polarized parallel to the plane of incidence over the spectral region investigated. The spectrum is characterized by a fairly rapid decrease in photon intensity at the shorter wavelengths to a minimum at 4500 to 5000 Å followed by a gradual rise to 5500 Å. In general, the measured intensities fall in the range from 1 to 10 ev per incident electron per unit solid angle per centimeter of wavelength. The spectral distribution of photons polarized perpendicular to the plane of incidence was found to be fairly flat with intensities ranging from 10% to 20% of those of the parallel component. The experimental results were compared with the generalized theory of transition radiation as formulated by Ritchie and Eldridge and with the low energy bremsstrahlung theory of Gluckstern, Hull, and Breit. The agreement between the measured intensities of the parallel polarized components and the calculated intensities of transition radiation was found to be good, especially at the higher energies. The experimentally measured perpendicular components were compared with the calculated perpendicular components of optical bremsstrahlung. Although the absolute agreement was not as good as in the case of transition radiation, the inverse energy dependence predicted by the Gluckstern-Hull-Breit theory was observed. Reasons for the observed discrepancies are presented. In the course of the experimental investigation, a calibration device was constructed with which a determination was made of the absolute efficiency of the concave diffraction gratings used in the Seya-Namioka geometry. The results of efficiency studies of several typical gratings are presented over a wide range of wavelengths. (auth)

37654 (ORNL-RMIC-1) RMIC BULLETIN. (Oak Ridge National Lab., Tenn.). June 1963. Contract [W-7405-eng-26]. 39p.

Five articles are included: separate abstracts were prepared for 3. The articles not abstracted in NSA contain information on the status of the RMIC and lists of available and required materials. (P.C.H.)

37655 (ORNL-RMIC-1(p.5-7)) PURIFICATION OF STARTING MATERIAL FOR POTASSIUM CHLORIDE SINGLE CRYSTALS. C. T. Butler (Oak Ridge National Lab., Tenn.).

The major methods of purification of starting material used to grow KCl single crystals of higher purity than those commercially available are reviewed. The problems of recontamination during the purification process and of verification of ultimate purity are also briefly examined. Of the various methods for purification of KCl, fractional crystallization, distillation (or sublimation), and zone refining seem to be the most widely used. (P.C.H.)

37656 (ORNL-RMIC-1(p.8-10)) LiF CRYSTALS WITH SELECTED ISOTOPIC RATIOS OF LITHIUM. C. F. Weaver, R. G. Ross, and R. E. Thoma (Oak Ridge National Lab., Tenn.).

The production of single 300 g Li^6F and Li^7F crystals and the results of spectroscopic and neutron activation analysis for impurities are reported. The annealed crystals were found to be strain-free by observation with polarized light and interference filters. Hydroxyl bands did not occur in the infrared absorption spectra, which indicates successful dehydration. Data on impurity content are tabulated. (P.C.H.)

37657 (ORNL-RMIC-1(p.11-38)) VARIATION OF SOME OF THE PHYSICAL PROPERTIES OF COMMERCIALLY AVAILABLE KCl SINGLE CRYSTALS. C. T. Butler, W. A. Sibley, and E. Sonder (Oak Ridge National Lab., Tenn.).

Data on the magnitude of variations in the irradiation coloring properties, luminescence, and light scattering in commercially available KCl crystals are presented. The data indicate that even trace impurities or other imperfections may strongly influence F-center formation. Support is given to previous findings that light scattering from KCl crystals grown in different ways can vary considerably in intensity. The results demonstrate that variations of the physical properties in presently available alkali halides may be very much larger than was realized. It is stressed that great care must be taken to ensure uniformity of samples; they should at least be taken from the same crystal ingot and preferably from the same section. (P.C.H.)

37658 (ORNL-TM-650) A TRANSIENT ANALYSIS OF FISSION PRODUCT DEPOSITION. M. N. Ozisik (Oak Ridge National Lab., Tenn.). Oct. 1, 1963. Contract W-7405-eng-26. 17p.

Time-dependent relations are derived for the deposition of fission products from gas streams to the surfaces of a conduit as a function of distance along the conduit using the heat-mass analogy. Deposition of both the precursor (i.e., particle which enters the gas stream first) and its first-daughter product are considered. This report supplements previous work in which the validity of heat-mass analogy for the deposition of radioisotopes was discussed and the steady-state relations were derived. (auth)

37659 (TID-19325) AN INVESTIGATION OF THE ELECTRICAL AND OPTICAL PROPERTIES OF SEMICONDUCTORS AND INSULATORS WHICH HAVE BEEN IRRADIATED BY FAST NEUTRONS. Final Report. (Arizona State Univ., Tempe). Aug. 1963. Contract AT(11-1)-715. 63p.

Colloidal Particles in Ionic Crystals. A study of optical extinction by cesium colloids in cesium bromide was carried out on additively colored crystals. Additive coloring was done in vacuum sealed copper capsules at 450 and 500°C. The colored crystals were quenched to form F centers. The F centers were converted to cesium colloids by bleaching with light. Annealing the crystals caused the colloid particle size to grow which resulted in a narrowing of the optical absorption band. Density to Mass Ratio of Conduction Electrons in Metals. Several tabulations of the effective density to effective mass ratios of Na, K, Rb, Cs, Ca, Sr, Ba, Cu, Ag, Au, and Al for different energies of

optical excitation are presented. The values of the m^*/m^* ratio were determined from the optical constants of bulk metal and from the optical extinction bands of transparent media carrying metallic precipitates. The formulas which relate the m^*/m^* ratios to the experimental data, and the literature sources of the data are given. The results of the tabulations are briefly discussed in relation to the electron theory of metals. Electron Micrographs of Alkali Halide Crystals Containing Colloidal Alkali Metal Particles. Cleaved surfaces of alkali halide crystals were replicated for examination under an electron microscope. Of these crystals, two groups of KCl crystals were additively colored, and one group of CsBr crystals was colored by x rays. Small shadowed spots appear on the electron micrographs of the crystals which were colored, and these spots were probably associated with colloidal particles of alkali metal. Some of the electron micrographs of the KCl crystals exhibit spots in the shape of polyhedra, apparently in support of observations of Simon and Sproull. (auth)

37660 (TID-19333) THE CESIUM-137 POWER PROGRAM. Quarterly Report No. 2. (Royal Research Corp., Hayward, Calif.). July 31, 1961. Contract AT(04-3)-366. 86p. (RRC-0101)

Research on cesium-137 power is described. Basic components are clarified, using criteria of safety, reliability, and longevity. It is found that a generator fueled with cesium-137 can be constructed to operate at a continuous power level of 5 watts and 12 volts in a sub-sea environment of great depth. Moreover, the generator may be easily transported to its destination because of its compactness and light weight. A cesium polyglass fuel form is developed into which a maximum of 43 per cent elemental cesium may be safely incorporated. Conversion of the raw fission product into a compound form suitable for firing is accomplished, proving that a single ion exchange column can achieve the desired results. Extraneous contaminants are entrained upon the column and the resulting product is elementally pure. Samples of cesium polyglass containing cesium-137 tracer are subjected to distilled and natural sea water solubility testing. Data indicate a decreasing rate of dissolution to less than 1 ppm per week, after 45 days of immersion at elevated temperatures. Investigation of heat transfer properties inherent to cesium-137 fuel results in the formulation of a thermal barrier of such excellence that only 21 thermal watts are expended in providing the required 500°C "hot shoe" temperature. The final configuration is a composite consisting of conductive and radiant heat barriers. Tests are conducted in an aqueous medium to 0°C as well as in ambient air. Approximately 1.9 in. of tungsten should be required to shield the source. The general configuration of the 5-watt device is determined and conceptual drawings made. (auth)

37661 (TID-19415) HIGH ENERGY PHYSICS AT TUFTS UNIVERSITY. Progress Report. (Tufts Univ., Medford, Mass.). Aug. 1963. Contract AT(30-1)-1984. 7p.

Theoretical research involving relativistic quantum field theory, scattering, and elementary particle theory is briefly described. The cross section for p-p bremsstrahlung was calculated, and the p-n cross section was measured to be 49 ± 2.1 mb. A method for determining a space-variable gamma-ray absorption coefficient from measurements related to its line integral was developed. A 1-ft thick prototype polarization-analyzing spark chamber for photoproduction experiments was also completed, and the use of the inverse double Compton effect to increase scattered photon energies in laser clashing photon-electron beam experiments was investigated. (D.C.W.)

37662 (UCRL-7087(Rev.1)) THE IONIZATION OF ALKALI ATOMS BY ELECTRON BOMBARDMENT. Forrest S. Baker and Gilbert O. Brink (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 1, 1962. Contract W-7405-eng-48. 33p.

A new experimental method was developed by which relative measurements of ionization cross sections can be normalized to absolute values. The method consists essentially of combining crossed-beam techniques, adsorption of gases on solid surfaces, and radiotracer detection. An atomic beam containing the radioactive tracer is crossed rectilinearly with an electron beam. The reaction products are adsorbed on collector surfaces and detected in a scintillation counter. The atomic beam is also quantitatively sampled by adsorption. Under consideration of experimental parameters, the value of the total ionization cross section is then directly proportional to the ratio of the counting rates R_{ion}/R_{beam}. The relative ionization cross-section curves of potassium, rubidium, and cesium were normalized and are presented. The values of α for the relation $Q_i = \alpha E^{-\beta}$ expressing the simple ionization cross sections as a function of electron energy are also given. The total scattering cross sections of potassium, rubidium, and cesium were partially resolved into their components. Finally, the autoionization structure of cesium is related to the known energy levels of the atom. (auth)

37663 (UCRL-7149) PHOTOEMISSION AND PHOTOMULTIPLIERS. W. E. Spicer (Stanford Univ., Calif.) and F. Wooten (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 7, 1962. Contract W-7405-eng-48. 31p.

A discussion is presented on photoemission and photomultipliers. A short description of the physics of photoemission is followed by a discussion of the measurement of photosensitivity, temperature dependence of photoemission, effect of cathode resistivity, response time, effect of initial velocity on transit time dispersion, and ultraviolet photoemitters. (auth)

37664 (UCRL-10601) COMMENTS ON THE ROLE OF DISLOCATIONS IN SUPERCONDUCTORS. E. R. Parker, J. Hull, I. P. Pratt, and V. F. Zackay (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1962. Contract W-7405-eng-48. 6p.

Previous findings on dislocations in superconductors are reviewed. It is suggested that the important roles played by dislocations in superconductors are those of electron scattering (rather than acting as superconducting pipes) and scavenging. The ability of dislocations to purify the neighboring material by attracting and capturing dissolved impurity atoms may well account for the marked enhancement of superconducting properties produced by plastic straining. (P.C.H.)

37665 (AEC-tr-6004) BOLTZMANN'S EQUATION IN THE KINETIC THEORY OF GASES. A. Ya. Povzner. Translated for New York Univ., New York, from Mat. Sb. (N.S.), 58: 62-7(1962). 27p.

Existence and uniqueness theorems for the solution of a Boltzmann equation, the derivation of which takes into account the possibility of spatial smearing of the collision process, are proved. (D.C.W.)

37666 (RSIC-42) SPECTROMETRY OF ELECTRON INTERFERENCE. I. ELECTRON OPTICAL PATTERNS FOR VELOCITY ANALYSIS. F. Leonhard. Translated for Redstone Arsenal, Ala. from Z. Naturforsch., 9a: 727-34(1954). 24p.

A high-resolution electron optical method for the

quantitative determination of the chromatic composition of electron interference diagrams from polycrystalline substances is described. An electrostatic velocity analyzer served as the dispersive element, and a slit-shaped section of a 50-kv beam Debye-Scherrer diagram was led through the lens analyzer producing a spectral decomposition sensitive to scattering energy losses of even a few ev. A description is given of the electron optical patterns and the experimental setup. (D.L.C.)

37667 (RSIC-43) SPECTROMETRY OF ELECTRON INTERFERENCE. II. EVALUATION OF THE INTERFERENCE SPECTROGRAMS AND A COMPARISON WITH THE THEORY. F. Leonhard. Translated for Redstone Arsenal, Ala. from Z. Naturforsch., 9a: 1019-31(1954). 30p.

The electron interference method was used with Al, Be, and Au foils to study the relative intensities of elastically and inelastically scattered electrons as functions of atomic number, thickness, angle, and chromatic distribution. The results were compared with theory. The following conclusions were made: The interference pattern of fast electrons contains unretarded as well as retarded electrons. The total elastic scattering on crystalline samples is smaller than that from Moliere and Debye's formula, and the discrepancy increases with atomic number and thickness. The inelastic scattering is higher than expected from theory, and the deviation also increases with atomic number. The atomic form factor function for Au disagrees with that calculated in the Born approximation. The total cross sections are also in disagreement with theory. (D.L.C.)

37668 STIMULATED EMISSION IN RARE-EARTH CHELATE (EUROPIUM BENZOYLACETONATE) IN A CAPILLARY TUBE. Erhard J. Schimitschek (Navy Electronics Lab., San Diego, Calif.). Appl. Phys. Letters, 3: 117-18(Oct. 1, 1963).

Stimulated laser action was observed in europium benzoylacetonate in a capillary tube. Line narrowing and spiking was observed. The spiking was of an irregular form similar to that from ruby. The pump light was delivered by a xenon flashtube. (C.E.S.)

37669 THE LAGRANGIAN IN GENERAL RELATIVITY THEORY (G.R.T.) AND RADIATION. L. Infeld (Univ. of Warsaw and Inst. of Physics, Polish Academy of Sciences, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 399-405(1963). (In English)

The derivation of the Lagrangian for moving particles in general relativity theory is outlined, and this Lagrangian is used to derive formulas for the gravitational radiation caused by particle motion under the influence of the metric field. Conditions and equations of motion that allow radiation are considered. (D.C.W.)

37670 STOPPING CROSS SECTIONS IN CARBON FOR LOW-ENERGY ATOMS WITH $Z \leq 12$. J. H. Ormrod and H. E. Duckworth (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 41: 1424-42(Sept. 1963).

The electronic stopping cross sections in (S_ϵ) in carbon for atomic projectiles with $Z \leq 12$ are determined in the energy interval from 10 to 140 kev. In doing so a Monte Carlo calculation is used to subtract from each experimentally observed cross section the contribution that arises from nuclear scattering. The trend of the results thus obtained agrees well with theory. In addition, however, a periodic dependence of S_ϵ on the atomic number of the projectile is observed. (auth)

37671 BREAKDOWN OF A RADIO-FREQUENCY DISCHARGE IN A NONRESONANT MAGNETIC FIELD. S. N. Sen and A. K. Ghosh (Univ. of North Bengal, Siliguri, Darjeeling, India). Can. J. Phys., 41: 1443-53(Sept. 1963).

The breakdown of a radio-frequency discharge excited by a radio-frequency voltage of frequency lying between 7 and 10 Mc is studied in a cylindrical discharge tube (length 10 cm) in air and in nitrogen with the pressure varying between 10 and 300 μ, in the presence of a nonresonant magnetic field varying from 0 to 80 gauss. The breakdown voltage is found to be greater than when no magnetic field is present for all values of pressure, and the pressure at which the breakdown voltage becomes minimum increases with the application of the magnetic field. A theory regarding radio-frequency discharge is modified by the introduction of effects due to the magnetic field, and an expression for the breakdown voltage and the pressure at which the breakdown voltage becomes minimum is deduced. The expression explains the observed results, and quantitative disagreement is ascribed to the uncertainty in the numerical values of the molecular constants introduced in the theory. The effect of attachment in the case of air is calculated within some limitations, and it is observed that when attachment is taken into consideration, the calculated theoretical values are in better agreement with the observed experimental results. (auth)

37672 ON PERTURBATION EXPANSIONS IN AXIOMATIC QUANTUM FIELD THEORY. P. Curtius (Eidgenossische Technische Hochschule, Zurich). Helv. Phys. Acta, 36: 389-404(1963). (In English)

It is shown that the perturbation expansions of axiomatic field theory can be described by Lagrangian formalism; and conversely that the perturbation series derived from Lagrangian formalism satisfy the conditions following from a perturbation treatment of the L.S.Z. (Lehmann, Symanzik, and Zimmermann) axioms. (auth)

37673 NUMERICAL DETERMINATION OF ION PATHS IN NONHOMOGENEOUS MAGNETIC FIELDS. A. C. Lilly, Jr., T. J. Weismann, and D. A. Lowitz (Gulf Research and Development Co., Pittsburgh). J. Appl. Phys., 34: 631-7 (Mar. 1963).

A practical numerical method for the determination of ion trajectories in the midplane of nonhomogeneous magnetic fields utilizing a computer program is discussed. The method of determining the field profiles and a comparison of the computed and experimental focusing properties of the field in the design of a double-focusing mass spectrometer are treated. (auth)

37674 INTERACTION OF A CONDUCTING FLUID STREAM WITH A TRAVELING WAVE OF MAGNETIC FIELD OF FINITE EXTENSION. R. N. Sudan (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys., 34: 641-50(Mar. 1963).

The a-c induction MHD generator with a channel of rectangular cross section and a polyphase winding as a source of the traveling wave of magnetic field of any arbitrary but finite length is treated as a boundary value problem. The solutions obtained indicate that the appropriate parameter that could be treated as a figure of merit for the channel is $\Gamma = 4\Omega/\mu\sigma U^2$, where Ω is the a-c frequency, U is the fluid velocity, and μ and σ refer to the fluid with their usual meaning. This parameter is inversely proportional to the magnetic Reynolds number with a characteristic length equal to the distance traveled by the stream in one period of the exciting alternating current. Expressions for the magnetic field, current density, power developed, power

output, and Joule losses in the channel are developed as well as their approximations for both large and small Γ. A method to eliminate the electromagnetic end effects due to the finite length of the channel by an appropriate distribution of the exciting current in the polyphase winding is also developed. The feasibility of building fractional wavelength MHD generators then becomes apparent. (auth)

37675 PARAXIAL SOLUTIONS FOR ACCELERATED AND DECELERATED AXIALLY SYMMETRIC SPACE-CHARGE FLOW. R. P. Borghi and D. A. Dunn (Stanford Univ., Calif.). J. Appl. Phys., 34: 692-702(Mar. 1963).

Particle trajectories in the presence of space charge are calculated for prescribed axial potential variations, including linear, parabolic, and sinusoidal variations, using the paraxial-ray equation including space charge for axial symmetry. Solutions are also presented for the potential as a function of distance corresponding to prescribed hyperbolic and parabolic trajectories. The off-axis equipotentials are calculated for some representative cases. These two-dimensional results are interpreted in the light of one-dimensional space-charge theory in which exact solutions can be obtained for the potential as a function of distance. Some of the limitations of the present theory in which either the potential or the trajectory is prescribed are pointed out. (auth)

37676 A COMPLETE E, P, V, T, S THERMODYNAMIC DESCRIPTION OF METALS BASED ON THE P, u MIRROR-IMAGE APPROXIMATION. Julius W. Enig (Naval Ordnance Lab., Silver Spring, Md.). J. Appl. Phys., 34: 746-54(Apr. 1963).

The well-known practice of using the mirror-image, in the P, u plane, of the shock Hugoniot curve about a vertical line through the shocked state P_H, u_H is shown to give a complete thermodynamic description of metals when the U (shock velocity) vs u_H relationship and $\alpha \equiv V^{-1}(\partial V/\partial T)_{P\approx 0}$ are known. Use of the experimental relationship $U = c_0 + au_H$ (a and c_0 constants) and α = constant, leads to a thermodynamic description that results in the metal appearing less compressible than if described by the Mie-Grüneisen equation of state. Furthermore, the existence of an anomalous behavior of c_p in the low pressure neighborhood (<10 to <50 kbar depending on the metal) of the initial state rules out the simultaneous existence of a Hugoniot satisfying the linear U vs u_H relationship, of isentropes satisfying the mirror-image assumption, and of a constant value of α in this neighborhood. Thermodynamic functions for 16 metals are calculated up to 2 Mbars and compared with the results obtained from the Mie-Grüneisen equation of state. (auth)

37677 SECONDARY ELECTRON EMISSION OF PYROLYTIC GRAPHITE CLEAVED IN A HIGH VACUUM. N. Rey Whetten (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 34: 771-3(Apr. 1963).

Pyrolytic graphite was cleaved in a high vacuum to obtain clean surfaces, and the secondary electron emission properties of these surfaces were determined. Pyrolytic graphite has a maximum secondary emission yield of 1.0 at 300-ev primary electron energy for electrons incident normal to the basal plane. The most probable energy of the emitted secondaries is 2 ev, with one-half of the secondaries having energy in excess of 8 ev. A maximum secondary emission yield of 0.75 at 350-ev primary energy was measured for normal incident electrons on a face that was perpendicular to the basal plane. The backscattered fraction for pyrolytic graphite was found to be 0.05. No differences were observed in the secondary electron emission properties of single-crystalline pyrolytic graphite and pyrolytic graphite that was less well ordered. (auth)

37678 SOME CAUSES OF RESONANT FREQUENCY SHIFTS IN ATOMIC BEAM MACHINES. I. SHIFTS DUE TO OTHER FREQUENCIES OF EXCITATION. Jon H. Shirley (National Bureau of Standards, Boulder, Colo.). J. Appl. Phys., 34: 783-8(Apr. 1963).

The quantum theory of an atomic beam machine is set up in matrix form. A new method is then used to derive the Bloch-Siegert shift in the resonance. The results are extended to the case of Ramsey-type excitation. Finally the Bloch-Siegert shift is computed for the present atomic beam frequency standards and found to be well below the accuracy of measurement. (auth)

37679 SOME CAUSES OF RESONANT FREQUENCY SHIFTS IN ATOMIC BEAM MACHINES. II. THE EFFECT OF SLOW FREQUENCY MODULATION ON THE RAMSEY LINE SHAPE. Jon H. Shirley (National Bureau of Standards, Boulder, Colo.). J. Appl. Phys., 34: 789-91(Apr. 1963).

The effect of slow frequency modulation of the exciting radiation on the Ramsey line shape observed in an atomic beam experiment is formulated theoretically. It is shown that the presence of second harmonic in the modulation can introduce measurable frequency shifts, whether observed directly or with a servo system. (auth)

37680 HUGONIOT EQUATION OF STATE OF PYROLYTIC GRAPHITE TO 300 kbars. D. G. Doran (Stanford Research Inst., Menlo Park, Calif.). J. Appl. Phys., 34: 844-51(Apr. 1963).

The Hugoniot equation of state of pyrolytic graphite of initial density 2.20 g/cm^3 was determined to 300 kb for the c direction. Various explosive techniques for producing the desired pressures, and the optical techniques employed in measuring shock and free-surface velocities are briefly described. It is found that shock and particle velocity are not linearly related below 70 kb. Above 100 kb, the material is less dense than is powdered natural graphite, as determined by Alder and Christian. The agreement with static compressibility data is satisfactory. (auth)

37681 THEORY OF THE PHASE TRANSITION IN A CYLINDRICAL SUPERCONDUCTOR. James C. Swihart (International Business Machines Corp., Yorktown Heights, N. Y.). J. Appl. Phys., 34: 851-4(Apr. 1963).

The theory of the transition of a macroscopic cylindrical superconductor from the superconducting to the normal state when induced by an external longitudinal magnetic field is considered. Iterative approximate solutions are found, and it is shown that a second-order solution previously derived by Faber is actually a poorer approximation than the first-order approximation from which it was obtained. (auth)

37682 DIFFRACTION OF FAST ELECTRONS AFTER SINGLE PLASMON LOSS. R. D. Heidenreich (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 34: 964-6(Apr. 1963).

The diffraction of eigen-loss electrons is examined in some detail. It is shown that the collision zone with a crystal is sufficiently diffused that a significant fraction (10% at $E = 10^5$ v) of $E_1 = E - \delta E$ electrons are produced outside the crystal boundaries. These electrons behave like an incident beam of energy E_1 and appear to be responsible for Watanabe's observations with an energy selecting electron microscope. (auth)

37683 DUO-EMITTER DIODE. K. G. Hernqvist and J. R. Fendley, Jr. (Radio Corp. of America, Princeton, N. J.). J. Appl. Phys., 34: 979-84(Apr. 1963).

Theoretical and experimental studies of the duo-emitter diode are described. In this diode an electron emitter and an ion emitter are facing each other. Two space-charge configurations were found for this diode, one where the interelectrode space is occupied by a dense plasma and one where potential barriers for the emitted particles exist near the emitters. The experiment, using a low-pressure cesium-vapor diode, gives results in good agreement with theory. (auth)

37684 ION BOMBARDMENT OF SINGLE CRYSTALS OF ALUMINUM. R. L. Cunningham, K. V. Gow, and Joyce Ng-Yelim (Dept. of Mines and Technical Surveys, Ottawa). J. Appl. Phys., 34: 984-9(Apr. 1963).

The results of bombarding the (100), (110), and (111) surfaces of aluminum single crystals with a narrow beam of 8-kv argon ions are presented. The crystals were tilted at the angles required to bring [110], [100], [112], and [111] directions parallel to the beam. The experiments were designed to study the effect of incident ion direction on ejection directions and etching rates. Ejection directions, as determined from the positions of deposits on hemispherical collectors, were found to be independent of incident ion direction for a given surface orientation. The quantity of material ejected along equivalent ejection directions was observed to decrease as the angle of deviation between the incident ion beam and the ejection direction increased. The principal ejection directions observed were [110]. Apparent [116] ejection directions were observed when (110) and (111) surfaces were bombarded. These were caused by an abrupt deflection of momentum from [110] directions of the crystal to directions close to [110] of elementary twins. These are formed by surface atoms in twin positions on (111) surfaces developed, in the case of the (110) surface, during bombardment. The [110] directions of an elementary twin are parallel to certain [114] directions of the crystal, and, had multilayer twins been formed, the resulting ejection would have been along apparent [114] directions as a result of Silsbee focusing. Ejection along apparent [116] directions was not observed from (100) surfaces presumably because predominant [100] surface grooves produced by bombardment could not contain (111) facets. Under these conditions [100] ejection was detected. Etching rates, as judged by the occurrence of matte spots, were least when the beam was parallel to the close-packed [110] directions and greatest when parallel to high index directions making large angles with the [110] directions. Low etching rates were also observed when the beam became parallel to [100] and [112] directions. Any anisotropy in surface migration rates was shown to be negligible in controlling etching rates under the conditions of these experiments. (auth)

37685 PROCEEDINGS OF THE EIGHTH SYMPOSIUM ON MAGNETISM AND MAGNETIC MATERIALS, NOVEMBER 12-15, 1962, PITTSBURGH, PENNSYLVANIA. J. Appl. Phys., 34: 1005-1390(Apr. 1963).

Papers pertinent to the understanding and applications of magnetism were presented. The topics included nuclear and antiferromagnetic resonance, thin films, change interactions and magnetic transitions, switching, magnetic anisotropy-spin waves, devices and instrumentation, magnetic moments and ordering, magnetoelastic and magneto-optic effects, ferrites, spin-wave instabilities and magnetoelastic coupling, magnetization processes, rare earths, and ferromagnetism-superconductivity. Separate abstracts are prepared for 33 of the 169 papers presented. Four papers were previously abstracted in NSA. (C.E.S.)

37686 HYPERFINE INTERACTIONS IN RARE-EARTH METALS. B. Bleaney (Univ. of Pittsburgh). J. Appl. Phys., 34: 1024-31(Apr. 1963).

Estimates of the hyperfine interaction constants for the rare-earth metals are compiled from electron spin resonance and electron-nuclear double resonance data on salts and atomic beam measurements on free atoms. Correction terms for second-order effects of the hyperfine structure are considered and shown generally to be small. Comparison with the experimental data shows close agreement in all cases except praseodymium, which is known not to have a co-operative phase. The temperature independent susceptibility of this metal below 4°K can be explained using a ferromagnetic exchange interaction of reasonable size, and the source of the observed hyperfine specific heat is discussed. In neodymium and samarium it is likely that crystal field effects are more important than exchange in determining the ground state in the co-operative phase. (auth)

37687 HYPERFINE FIELDS AND MAGNETIC MOMENTS IN THE Fe–Rh SYSTEM. G. Shirane (Westinghouse Research Labs., Pittsburgh), C. W. Chen, P. A. Flinn, and R. Nathans. J. Appl. Phys., 34: 1044-5(Apr. 1963).

Hyperfine fields and isomer shifts of Fe^{57} in the Fe–Rh system were measured by the Mössbauer technique in the composition range between 0 and 52 at.% Rh. When the Rh concentration exceeds 25%, chemical ordering of CsCl type develops and two distinct hyperfine fields are observed, corresponding to Fe on Fe sites (Fe I) and Fe on Rh sites (Fe II). For example, $H_i(I) = 277$ kOe and $H_i(II) = 384$ kOe in an alloy containing 48% Rh. Neutron diffraction study of this alloy gives $\mu_{Fe} = 3.2\ \mu_B$ and $\mu_{Rh} = 0.9\ \mu_B$. It is suggested that Fe II, which is surrounded by 8 Fe nearest neighbors, may have a smaller magnetic moment than Fe I despite its higher hyperfine field. These results are consistent with a model in which the polarization of conduction electrons is negative and its magnitude is reduced when rhodium replaces iron as nearest neighbors. (auth)

37688 ANTIFERROMAGNETISM IN fcc AND hcp IRON–MANGANESE ALLOYS: MÖSSBAUER EFFECT. Clyde Kimball (Ford Motor Co., Newport Beach, Calif.), W. D. Gerber, and Anthony Arrott. J. Appl. Phys., 34: 1046-7(Apr. 1963).

That metallic antiferromagnetism can be verified by employing the Mössbauer effect was demonstrated for f-c-c Fe–Mn alloys near the compositions of equal atomic fractions and for a h-c-p Fe–Mn alloy with 17% Mn. The hyperfine fields deduced from measurements of line broadening of incompletely resolved spectra give 33, 39, 43, 42, and 22 kG for 60, 50, 45, and 43% Mn in the f-c-c phase and 17% Mn in the h-c-p phase, respectively. The uncertainty is estimated at ±2.5 kG. Néel temperatures of 500°K are found for the four f-c-c alloys. The h-c-p alloy has a Néel temperature of 240°K. These values agree with resistivity and susceptibility data. In the light of this treatment of incompletely resolved spectra, a suggested reinterpretation of previous data on antiferromagnetic Cr is offered. (auth)

37689 EXCITATION OF NUCLEAR MAGNETIC RESONANCE MODES IN ANTIFERROMAGNETIC $KMnF_3$. A. M. Portis, G. L. Witt, and A. J. Heeger (Univ. of California, Berkeley). J. Appl. Phys., 34: 1052-3(Apr. 1963).

The Mn^{55} nuclear resonance absorption in $KMnF_3$ was

monitored through the observation of antiferromagnetic resonance at 4.2°K and below. It is found that with increasing r-f power a second antiferromagnetic resonance grows at a shifted field position. At 4.2°K a shifted resonance can be observed for driving frequencies between 580 and 680 Mc. As the driving frequency is reduced the position of the shifted resonance moves toward that of the unshifted line. These results are interpreted in terms of the nucleation of regions of the sample with nuclear resonance at the driving frequency. Such regions are present in the absence of excitation as the result of electronic pinning. With r-f excitation these regions are expected to grow. The power level at which substantial growth takes place is in good agreement with theory. (auth)

37690 MAGNETO-CALORIC EFFECTS IN GADOLINIUM TRICHLORIDE. G. Garton, M. J. M. Leask, W. P. Wolf, and A. F. G. Wyatt (Clarendon Lab., Oxford). J. Appl. Phys., 34: 1083-4(Apr. 1963).

Measurements are reported of the temperature changes that accompany isentropic magnetization of $GdCl_3$ at temperatures between 1.2 and 4°K with fields between 0.5 and 8.4 kG. At the Curie temperature 2.20°K, temperature changes of ~0.5°/kG were found. Using the results of earlier zero-field specific heat measurements, an entropy diagram was constructed, and from this the variation of specific heat with temperature in various fields calculated. The general behavior is well explained by a simple molecular field theory based on high temperature susceptibility measurements. (auth)

37691 THERMAL PROPERTIES OF DYSPROSIUM ALUMINUM GARNET NEAR THE NÉEL TEMPERATURE. M. Ball, M. J. M. Leask, W. P. Wolf, and A. F. G. Wyatt (Clarendon Lab., Oxford). J. Appl. Phys., 34: 1104-5 (Apr. 1963).

Measurements of the specific heat of $Dy_3Al_5O_{12}$ at temperatures between 1.2 and 4°K are described. A sharp λ anomaly was found at 2.49°K, and this is discussed in terms of an unusual type of antiferromagnetic ordering previously deduced from magnetic susceptibility and resonance experiments. Two different estimates are made of the mean interaction energy, and these show that about 70% of the total interaction is due to magnetic dipole-dipole coupling. An estimate of the entropy is in excellent agreement with the assumption that the Dy^{3+} ions may be described in terms of only one Kramers' doublet $S' = \frac{1}{2}$. (auth)

37692 MEASUREMENT OF THE COVALENT SPIN DISTRIBUTION IN MANGANOUS FLUORIDE USING POLARIZED NEUTRONS. R. Nathans (Brookhaven National Lab., Upton, N. Y.), H. A. Alperin, S. J. Pickart, and P. J. Brown. J. Appl. Phys., 34: 1182-8(Apr. 1963). (BNL-6487)

The spatial distribution of the covalent spin density in MnF_2 was obtained from a measurement of the forbidden magnetic scattering in the nuclear reflections using polarized neutrons. A partial Fourier map of the projected covalent spin on the basal plane was prepared. A model representing the covalent spin by isolated spherical charges that are consistent with the experimental data indicates that the covalent spin density for a single bond undergoes a change in sign as we proceed from the Mn^{2+} to the F^- ion. That part closest to the 3d unpaired electrons carries the same sign as the magnetic ion. The results are discussed in terms of the existing theory. (auth)

37693 ATOMIC MAGNETIC MOMENTS IN DILUTE IRON–PALLADIUM ALLOYS. J. W. Cable, E. O. Wollan, and W. C. Koehler (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 34: 1189-90(Apr. 1963).

Neutron scattering and magnetization measurements were made on dilute iron–palladium alloys to determine the existence and magnitude of the magnetic moments of the constituent atoms. This determination was made by the combination of the difference in the aligned magnetic moments obtained from the ferromagnetic diffuse neutron scattering and the average ferromagnetic moment per atom obtained from the saturation magnetization measurements. Data were taken on two alloys that contained 3 and 7 at.% Fe. (auth)

37694 MAGNETIC MOMENT DISTRIBUTIONS IN DILUTE NICKEL ALLOYS. G. G. E. Low and M. F. Collins (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Appl. Phys., 34: 1195-9(Apr. 1963).

A neutron scattering technique was developed that enables the spatial distribution of the magnetic moment disturbance around an impurity atom in a ferromagnet to be examined over a distance of several Angstroms. Measurements show that when vanadium or chromium is added dilutely to nickel the resulting magnetic disturbance occurs not only at the impurity atom sites themselves, but also on the neighboring nickel sites. In fact, most of the change in saturation magnetization observed on alloying is due to a decrease in the moments on nickel atoms in the vicinity of solute atoms rather than to changes in moment at the impurity atom positions. On the other hand, if iron or manganese is added dilutely to nickel the moment disturbance appears to be confined to the solute atoms. These results are discussed in terms of a theory suggested by Friedel. (auth)

37695 ASPHERICAL SPIN DENSITY IN THE FERRIMAGNETIC COMPOUND Mn_2Sb. H. A. Alperin (Naval Ordnance Lab., Silver Spring, Md. and Brookhaven National Lab., Upton, N. Y.), P. J. Brown, and R. Nathans. J. Appl. Phys., 34: 1201-2(Apr. 1963). (BNL-6484)

The spatial distribution of the unpaired electrons about each manganese atom in the ferrimagnetic compound Mn_2Sb was measured by diffraction of polarized neutrons from single crystals at room temperature. It is found that this distribution is aspherical and highly compact. The moments for the manganese atoms at the 2a and 2c positions are measured to be -1.48 ± 0.15 and $2.66 \pm 0.15\ \mu_B$, respectively. Single-crystal x-ray determination of the manganese and antimony 2-c position parameters for this structure yields the values 0.2897 ± 0.0006 and 0.7207 ± 0.0002, respectively. An unusual feature of the spin density of the manganese atom at the 2-c position is the displacement of the center of the distribution from its nuclear position. (auth)

37696 NEUTRON DIFFRACTION INVESTIGATION OF Pt-BASED ALLOYS OF THE FIRST TRANSITION SERIES. S. J. Pickart (Naval Ordnance Lab., Silver Spring, Md. and Brookhaven National Lab., Upton, N. Y.) and R. Nathans. J. Appl. Phys., 34: 1203-4(Apr. 1963). (BNL-6483)

Polarized neutron diffraction measurements show that the radial spin density of the Mn atom in ferromagnetic $MnPt_3$ is contracted relative to the Mn^{2+} distribution, while that of Cr in ferrimagnetic $CrPt_3$ is more expanded. An antiferromagnetic structure was detected in the ordered CrPt phase at room temperature in which the spins are antiferromagnetic within each layer. (auth)

37697 INTERACTIONS IN VARIOUS MAGNETIC COMPOUNDS. E. W. Gorter (Philips' Gloeilampenfabrieken,

Eindhoven, Netherlands). J. Appl. Phys., 34: 1253-9(Apr. 1963).

Susceptibility measurements on single crystals of $KFe_{11}O_{17}$ show an anomalous antiferromagnetic behavior, which is referred to as antiferrimagnetism. The behavior follows from Weiss field theory on a simplified model. The magnetic structure of K_2NiF_4 was determined by neutron diffraction by Legrand and Plumier. Measurements on their single crystal show that $\chi||$ and $\chi\perp$ become nearly equal at ≈100°K, i.e., far below the temperature where χ is maximum. This is believed to be due to a gradual breaking up of the long-range order in the basal layers. Results obtained on powders of $La_{0.5}Sr_{1.5}MnO_4$ and $La_{1.5}Sr_{0.5}CoO_4$ are also given. Pure polycrystalline samples of EuS, EuSe, and EuTe with rocksalt structure show θ values of +16, +6, and −7°K; EuTe has a Néel temperature at +11°K. The ferromagnetism of EuO, EuS, and EuSe is due to a predominant direct positive exchange interaction Eu−Eu, the antiferromagnetism of EuTe to a predominant next-nearest neighbor superexchange interaction Eu−X−Eu. Neither interaction is believed to change sign in the series. Measurements of M vs T at various field strengths are in very good agreement with Weiss field theory. Oxidic spinels with diamagnetic ions in A sites have so far shown negative θ values. The substances $Ge[Fe_2]O_4$, $Ge[Co_2]O_4$, and $Ge[Ni_2]O_4$ have θ values of −15, +90, and 0°K, respectively. The materials $Ge[Ni_{2-2\delta}Li_\delta Fe^{III}_\delta]O_4$ have positive θ values, increasing linearly with δ to 180°K for $\delta = 0.5$. Here the $Ni^{2+}-Fe^{3+}$ interaction must be positive and this interaction is thought to be a direct one, as is discussed. (auth)

37698 RARE-EARTH ION RELAXATION IN FERRIMAGNETIC RESONANCE. B. H. Clarke, R. F. Pearson, R. W. Teale, and K. Tweedale (Mullard Research Labs., Redhill, Surrey, Eng.). J. Appl. Phys., 34: 1269-70 (Apr. 1963).

The linewidths in ferrimagnetic resonance ΔH and the frequency dependence of the anisotropy field for iron garnets containing rare-earth ions are explained on the basis of a model for relaxation that was used by Clogston for nickel ferrous ferrite. It is assumed that the population of the rare-earth ion energy levels relaxes toward equilibrium with a finite relaxation time τ. Consequently for $\omega\tau \gtrsim 1$, where ω is the measurement frequency, significant departures from equilibrium occur and give rise to the effects noted above. If the static torque, linewidth, and the resonant field can be measured in a temperature range where only the lowest two rare-earth ion energy levels are appreciably populated, τ can be deduced for the magnetization along [100] and [110]. The consequences of the model are described; they differ quite extensively from those of the fast relaxing ion model. A quantitative comparison with the theory for iron garnets containing ytterbium supported the theory and yielded values for τ. In the case of erbium, however, the static torque was found to be strongly field dependent and hence only a qualitative comparison is possible. It is nevertheless concluded that the effects observed support the model. At 55°K τ for the ground doublet is about 10^{-11} sec. (auth)

37699 MODIFIED STRONTIUM FERRITE, A NEW PERMANENT MAGNET MATERIAL. A. Cochardt (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 34: 1273-4(Apr. 1963).

A review of the magnetoplumbite magnet development is given from the early magnets of Takei to the recent high energy barium ferrite magnets of Tomholt. A method for rapidly testing a large number of ferrite permanent magnet specimens is described that was used on several thousand specimens. The results are summarized for portions of the ternary systems $M_1O \cdot M_2O \cdot Fe_2O$, where M_1 and M_2 stand for Ba, Sr, Pb, or Ca. A modified strontium ferrite magnet could be developed which appears to have a higher magnetic energy than any other oxide magnet material previously known. Typical values are: B_r = 4100 G, $_1H_c$ = 3000 Oe, $(BH)_{max}$ = 4.0 mgo. At lower coercive forces and under careful laboratory conditions, modified strontium ferrite magnets can be prepared with a $(BH)_{max}$ approaching 5 mgo. A number of permanent magnet applications are mentioned for which the new material is most suitable. (auth)

37700 PARALLEL PUMPING IN PLANAR Zn_2Y. J. J. Green and B. J. Healy (Raytheon Co., Waltham, Mass.). J. Appl. Phys., 34: 1285-6(Apr. 1963).

Parallel pump absorption measurements were made on a single-crystal sphere and a single-crystal thin flake of Zn_2Y. The imaginary part of the susceptibility in each sample reaches a maximum value of about 2 for an r-f magnetic field in the vicinity of 25 Oe. The dependence of the critical r-f magnetic field upon d-c magnetic field is compared to the theory of Bady and Schlömann and the agreement is found to be reasonably good. From the minimum r-f critical field, spin-wave linewidths of 8.0 Oe for the sphere and 9.24 Oe for the thin flake were calculated. (auth)

37701 IRRADIATION OF MAGNETIC MATERIALS WITH 1.5- AND 4-Mev PROTONS. R. S. Sery and D. I. Gordon (Naval Ordnance Lab., Silver Spring, Md.). J. Appl. Phys., 34: 1311-12(Apr. 1963).

Pure iron and 5% molybdenum Permalloy samples, 0.01 in. thick, were irradiated with 1.5 and 4-Mev protons at total incident integrated fluxes of 10^{16} and 10^{17} protons per cm^2. The actual shapes used were a ring $^{13}/_{16}$-in. o.d. × $^5/_8$-in. i.d. and a disk of $^5/_8$-in. diameter. The ring was utilized for d-c magnetic property measurements (before and after irradiation) while the disk was used for magnetic anisotropy torque measurements. The remanence (B_r) and maximum permeability (μ_m) of molybdenum Permalloy decreased by about 35%. This is of the same order of change produced by neutron irradiation of 10^{17} n/cm^2 in this material. However, measurements to date indicate that changes in coercive force and initial permeability due to proton irradiation are relatively small as compared with neutron irradiation effects. The decreases in B_r and μ_m of the pure iron samples were of the order of 10 to 20% for irradiations of both ~10^{16} and ~10^{17} protons/cm^2. Both materials were essentially isotropic initially. Post irradiation torque measurements showed that the materials became slightly more isotropic. No changes were observed in saturation magnetization. Heating of control samples to 250°C did not produce changes in magnetic properties, showing that temperature alone is not a factor in producing the permanent changes that occurred under irradiation. All irradiations were performed at temperatures below 250°C. The changes due to proton irradiation are thought to be due to proton-induced disordering. (auth)

37702 MAGNETIC STRUCTURE INVESTIGATIONS AT THE NUCLEAR CENTER. R. Ballestracci, E. F. Bertaut, J. Coing-Boyt, A. Delapalme, W. James, R. Lemaire, R. Pauthenet, and G. Roult (Laboratoire d'Electrostatique et de Physique du Metal and Centre d'Etudes Nucléaires, Grenoble, France). J. Appl. Phys., 34: 1333-4(Apr. 1963).

The magnetic structure of the compounds UOS, β-$CoSO_4$, YCo_3, and $HoCo_3$ is briefly described. UOS is antiferromagnetic. The Néel temperature is T_n = 55°K. The mag-

netic cell is doubled in the c direction with a ++−− sequence of U moments along c. The apparent spin is S ~ 1. The negative interaction corresponds to U−O−U links. In β-$CoSO_4$ (high-temperature modification, space group Pbnm), Co atoms are in 000, $00\frac{1}{2}$, $\frac{1}{2}\frac{1}{2}\frac{1}{2}$, $\frac{1}{2}\frac{1}{2}0$. Here three different antiferromagnetic spin modes, mutually perpendicular, $A_x(+--+)$, $G_y(+-+-)$, and $C_z(++--)$, in the Wollan-Koehler notation, are coupled. Direction cosines are 0.71, 0.50, and 0.50, respectively. The Co moment is about 3.84 μ_B at 4.2°K. A field-induced spin flip to the configuration F_x, C_y, G_z is predicted. YCO_3 is ferromagnetic at room temperature with a moment value of Co practically equal to that of metallic Co and moment direction along c, which is conserved down to 4.2°K. In $HoCo_3$ the moment of Ho is opposite to those of the Co atoms. When cooling from room to liquid helium temperature, the direction of easy magnetization changes from near c to a direction in the basal plane and the Ho moment increases from 4 to about 9 μ_B. The compensation temperature is 70°K. (auth)

37703 SOME MAGNETIC STRUCTURE PROPERTIES OF TERBIUM AND OF TERBIUM−YTTRIUM ALLOYS. W. C. Koehler, H. R. Child, E. O. Wolland, and J. W. Cable (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 34: 1335-6(Apr. 1963).

Neutron diffraction studies were made on single-crystal and polycrystalline specimens of terbium. Earlier magnetic and thermal measurements indicated a transformation to an ordered magnetic state at approximately 230°K, and a subsequent order-order transformation at approximately 220°K. The neutron measurements show that in the narrow antiferromagnetic region, the magnetic structure of terbium is a helical structure. The interlayer turn angle varies from 20.5° per layer at the Néel point to 18.5° per layer at the lower transition. At this lower temperature the structure transforms, in the absence of any external applied field, to a classical ferromagnetic structure in which the moments are in, or nearly in, the planes perpendicular to the hexagonal axis. At very low temperatures the magnetic moment per atom is very nearly 9.0 Bohr magnetons, the value expected for the ordered tripositive ion. Neutron diffraction measurements were also made on a series of alloys of yttrium and terbium in order to study the influence of magnetic dilution on the magnetic properties of the rare-earth metals. Introduction of yttrium into terbium reduces the Néel temperature and broadens the range of existence of the helical phase. At 30 at.% yttrium and above, the spontaneous transformation to the ferromagnetic state is not observed, for zero applied field, even for temperatures as low as 4.2°K. As in pure terbium the interlayer turn angle ω of the helical structure in the alloys varies with temperature, but the slope of the ω vs temperature curve becomes smaller with increasing yttrium concentration. (auth)

37704 CRYSTAL STRUCTURE OF DYSPROSIUM AT LOW TEMPERATURES. F. J. Darnell and E. P. Moore (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Appl. Phys., 34: 1337-8(Apr. 1963).

The temperature dependence of the lattice parameters of Dy was studied from room temperature to 30°K. The previously reported expansion along the c axis of the hexagonal close-packed structure below T_N = 179°K was observed in detail and found to be in agreement with predictions of Kittel. At the first-order antiferromagnetic-ferromagnetic transition T_S = 86°K a crystal structure distortion to orthorhombic was observed. The ratio of orthorhombic axes changes from b/a = 1.732 = $\sqrt{3}$ to 1.720 just below T_S and to 1.715 at 30°K. (auth)

37705 THERMODYNAMIC SELF-CONSISTENT THEORY OF INDIRECT EXCHANGE IN METALS. T. A. Kaplan (Massachusetts Inst. of Tech., Lexington). J. Appl. Phys., 34: 1339-41(Apr. 1963).

A theory of indirect exchange forces (so-called s−d or s−f exchange) is given, based on Peierl's statistical mechanical variational principle. A set of determinantal states, $|M_1 \cdots M_N) = |M)$, is considered where $|M_i| \leq S$, the localized spin, and N is the number of localized spins, the ith spin being quantized along some direction $\hat{z}_i$; in each of these determinants, the conduction electrons occupy general band orbitals Φ_k which are constant over the set. The energies, $E_M^0 = (M|H|M)$, are of course functionals of the Φ_k; varying the partition function with respect to the Φ_k then leads to Hartree−Fock-like (HF) equations for the Φ_k which involve the thermal averages $\overline{M}_i$ of the localized spins, which in turn are given as functions of the Φ_k. A particular type of solution, a spiral, is shown to exist insofar as symmetry is concerned; in connection with this proof a generalization of the Bloch translational symmetry theorem is given. Neglecting entirely the band-band exchange terms (which would give rise to Overhauser's spin-density waves), the spiral wave vector is the same as in the well known indirect "s−f" exchange theory in the limit $\overline{M}_i \to 0$ (i.e., as the Néel temperature is approached). For finite $\overline{M}_i$, the approach provides a reasonable generalization, giving the expected energy gaps due to the magnetic long range order. It is shown that the corresponding band structure exhibits spin-density waves even though their source in Overhauser's theory was eliminated. The temperature dependence of the gaps plus the implied changes in the Fermi surface gives rise to temperature-dependent effective exchange integrals that cause a thermal variation in spiral wavelength. (auth)

37706 SOME MAGNETIC PROPERTIES OF Gd SINGLE CRYSTALS. C. D. Graham, Jr. (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 34: 1341-2(Apr. 1963).

The magnetocrystalline anisotropy constants of Gd were measured from 10 to 350°K. The behavior near the Curie temperature (about 300°K) is unusual: a fairly large, strongly field-dependent apparent anisotropy persists to temperatures at least 30° above the Curie temperature, and in the range 250 to 285°K this anisotropy decreases with increasing field above 4 kOe. Preliminary high-field (20 kOe) magnetization measurements indicate that there is no large difference in magnetization in different crystallographic directions in the vicinity of the Curie temperature. Low-field magnetization measurements from 77 to about 300°K are in qualitative agreement with curves calculated from the anisotropy constants, and do not support the suggestion of Belov and Pedko that Gd has a spiral spin structure in low fields above 210°K. (auth)

37707 MICROWAVE ABSORPTION IN GADOLINIUM−YTTRIUM ALLOYS. J. Popplewell and R. S. Tebble (Univ. of Sheffield, Eng.). J. Appl. Phys., 34: 1343-4(Apr. 1963).

The paramagnetic, antiferromagnetic, and ferromagnetic states of the gadolinium−yttrium alloy system were examined by microwave resonance techniques. The paramagnetic g values are found to be concentration dependent ranging from 1.96 ± 0.03 in pure gadolinium to 2.13 ± 0.05 in the 3.7% gadolinium alloy. The results, in particular the experimentally determined g shifts, are discussed in terms of the Yosida development of Zener's proposal that the coupling between d (or f) spins is brought about by exchange interaction with the polarized conduction electrons. (auth)

37708 MAGNETIC PROPERTIES OF SOME DIVALENT EUROPIUM COMPOUNDS. T. R. McGuire, B. E. Argyle, M. W. Shafer, and J. S. Smart (International Business Machines Corp., Yorktown Heights, N. Y.). J. Appl. Phys., 34: 1345-6(Apr. 1963).

Samples of EuS, EuSe, EuTe, $EuCO_3$, $EuTiO_3$, $EuZrO_3$, $EuSO_4$, and $EuCl_2$ were prepared, and their magnetic properties were studied in the temperature range 4–300°K. The sulfide, selenide, and telluride all have the same NaCl crystal structure as EuO; it is found that the first two also become ferromagnetic at low temperature, while EuTe is paramagnetic, or possibly antiferromagnetic, at 4.2°K. The Curie temperatures for EuS and EuSe are about 18 and 7°K, respectively. The saturation moments of EuS and EuSe extrapolated to 0°K correspond to 6.8 and 6.7 μ_B per Eu^{2+} ion, respectively, in good agreement with the expected value of 7 μ_B. None of the other compounds were ferromagnetic at liquid helium temperatures, and all exhibited θ values very near to 0°K. A tentative interpretation of the exchange interactions in the rocksalt compounds is made using a molecular field treatment. (auth)

37709 MAGNETIC PROPERTIES OF COMPOUNDS OF MANGANESE WITH RARE-EARTH ELEMENTS HAVING THE CUBIC LAVES PHASE STRUCTURE. E. A. Nesbitt, H. J. Williams, J. H. Wernick, and R. C. Sherwood (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 34: 1347-8(Apr. 1963).

Four cubic Laves-phase compounds containing manganese were investigated. All four compounds $TbMn_2$, $GdMn_2$, $DyMn_2$, and $HoMn_2$ were found to have antiferromagnetic coupling. At low temperatures and appropriate magnetic fields, sharp peaks in the magnetization versus temperature curves were obtained. In general, these peaks shifted to lower temperatures as the strength of the magnetic field was increased. In the compound $TbMn_2$, the peaks strongly persisted even at a field of 14,400 Oe. In addition, the properties of $TbMn_2$ were drastically affected by cooling in a magnetic field and under these conditions its hysteresis loop was unsymmetrical. (auth)

37710 MAGNETIC CHARACTERISTICS OF PRASEODYMIUM, NEODYMIUM, AND SAMARIUM HYDRIDES. Yoshio Kubota and W. E. Wallace (Univ. of Pittsburgh). J. Appl. Phys., 34: 1348-50(Apr. 1963).

Magnetization-temperature data are presented for the hydrides $PrH_{2.02}$ to $PrH_{2.71}$, $NdH_{2.02}$ to $NdH_{2.75}$, and $SmH_{1.99}$ to $SmH_{2.86}$ and for the three parent metals from 4.2 to 300°K. Of the twelve hydrides examined only $NdH_{2.02}$ and $NdH_{2.03}$ exhibited magnetic ordering. These hydrides exhibited a Curie point at 9.5°K and the saturation moment measured at 4.2°K was 1.36 μ_B per Nd atom. Assuming the applicability of a Brillouin function with $J = 9/2$ the moment extrapolated to 0°K is 1.51 μ_B. These values are considerably lower than the value for the free tripositive ion (3.27 μ_B) or the moment observed in the paramagnetic region (3.40 μ_B) but are in reasonably good agreement with the theoretical value (1.58 μ_B) computed for 4.2°K taking into account crystal field effects. The susceptibility behavior of the four Sm hydrides studied is generally similar. The trend with temperature is in reasonably good agreement with theory that treats Sm as a free tripositive ion. Susceptibility of the Nd hydrides follows the Curie–Weiss law above about 100°K with the expected slope but deviates negatively from it at lower temperatures. The deviations are attributed to either incipient ferromagnetic ordering or crystal field effects or a combination of the two. The susceptibility behavior of the Pr hydrides is very unusual. The highest hydrides exhibit Curie–Weiss behavior above about 80°K but show positive deviations from linearity in $1/\chi$ vs T at lower temperatures. That the deviations may be due to crystal field effects is considered possible but unlikely. $PrH_{2.03}$ and $PrH_{2.04}$ exhibit essentially identical susceptibility behavior and do not follow the Curie–Weiss law. Their susceptibilities are anomalously high near room temperature, exceeding the values for the element and the saturated hydride by a factor of about five. (auth)

37711 MAGNETIC STRUCTURES OF TbD_2 AND HoD_2. D. E. Cox (Westinghouse Research Labs., Pittsburgh), G. Shirane, W. J. Takei, and W. E. Wallace. J. Appl. Phys., 34: 1352-4(Apr. 1963).

TbD_2 and HoD_2 have the calcium fluoride type of structure and become antiferromagnetic below 40 and 8°K, respectively. A powder neutron diffraction study of TbD_2 at 4°K revealed a sinusoidal modulation of basic magnetic ordering of the first kind, in which ferromagnetic (001) layers are coupled antiparallel to the two adjacent layers. Both the magnetic moment and the wave vector are directed along the [001] axis, with a periodicity of about 24 Å. The moment associated with the Tb ion is 7.9 μ_B. The diffraction pattern observed for HoD_2 was quite complicated and attempts to index the magnetic reflections either with multiple cell dimensions or with simple modulation of a few basic antiferromagnetic structures proved unsuccessful. (auth)

37712 STRUCTURAL AND MAGNETIC CHARACTERISTICS OF DYSPROSIUM–YTTRIUM SOLID SOLUTIONS. S. Weinstein, R. S. Craig, and W. E. Wallace (Univ. of Pittsburgh). J. Appl. Phys., 34: 1354-5(Apr. 1963).

X-ray studies showed that dysprosium and yttrium are miscible in all proportions in the solid state at room temperature. Vegard's law is approximately obeyed. Thermomagnetic analyses were carried out between 4°K and room temperature and the field dependencies were measured at liquid He, liquid N_2, and room temperature on alloys containing from 10 to 95 at.% Dy. Alloys containing less than 90 at.% Dy are paramagnetic at room temperature and antiferromagnetic at lower temperatures with no clear evidence of ferromagnetism down to liquid He temperatures. The Néel point (T_N) decreases with decreasing Dy content, T_N varying linearly with composition. Alloys containing 90 and 95 at.% Dy are ferromagnetic at low temperatures. When the samples were cooled to 4°K in the absence of a field and the magnetization measured as the sample warmed up in a field, it was observed that the moment was initially low as if the sample were antiferromagnetic (or at least nonferromagnetic). With increasing temperature the moment rose sharply to a broad maximum at about 30°K. This was followed by the appearance of Curie and Néel points. When the sample was cooled in the presence of a field, the decreased moment at low temperatures was not observed. (auth)

37713 MAGNETIC CHARACTERISTICS OF LAVES PHASES CONTAINING LANTHANIDE METALS COMBINED WITH NICKEL. E. A. Skrabek and W. E. Wallace (Univ. of Pittsburgh). J. Appl. Phys., 34: 1356-7(Apr. 1963).

Studies were made of the series of compounds represented by the formula ANi_2, in which A is Y, Ce, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er, Tm, and Lu. These compounds are all isostructural, possessing the $MgCu_2$ structure. Nine of the compounds exhibit magnetic ordering at temperatures ranging from 8 to 90°K. The Y, Ce, and Lu remain paramagnetic down to liquid helium temperatures. YNi_2 and $LuNi_2$ exhibit Pauli paramagnetism from 4 to

300°K suggesting that nickel has a filled 3d shell and is not carrying a moment in these phases. $CeNi_2$ likewise exhibits Pauli paramagnetism, which implies that Ce was ionized to the quadripositive state. The measured saturation moment extrapolated to 0°K is in good agreement with the value expected if nickel is nonmagnetic and the lanthanide component carries the moment of the free tripositive ion in the case of $GdNi_2$ but is in poor agreement for the eight other compounds which order magnetically. For all except $SmNi_2$, which appears to be a special case, the observed moment is less than that of the free ion, the discrepancy ranging from 78% for $PrNi_2$ to 28% for $HoNi_2$. The low moment is attributed to the quenching effect of the crystal field, but the possibility cannot be excluded that these are not simple ferromagnets. The moment for $SmNi_2$ is 6.3 μ_B, as compared with 0.71 μ_B for the ground state free tripositive ion (L−S coupling). The origin of the high moment for this compound is not understood. Its magnitude can be rationalized in terms of a change to L + S coupling. (auth)

37714 HIGH-FIELD MAGNETORESISTANCE IN NICKEL SINGLE CRYSTALS. S. M. Marcus and D. N. Langenberg (Univ. of Pennsylvania, Philadelphia). J. Appl. Phys., 34: 1367-9(Apr. 1963).

Measurements of transverse and longitudinal magnetoresistance in pure single crystals of nickel are reported. In the samples studied both the longitudinal and the transverse magnetoresistance tend to saturation at high fields and the transverse magnetoresistance is quite isotropic. Comparison of these data with that of other workers shows that Kohler's rule is not obeyed in nickel and indicates that the observed tendency to saturation and lack of gross anisotropy are not characteristic of the Fermi surface topology in nickel. It is suggested that impurity scattering mechanisms peculiar to ferromagnetic metals play a major role in determining the characteristics of the magnetoresistance even at the threshold of the high-field region. (auth)

37715 FERROMAGNETISM OF UFe_2 AND COMPARISON WITH THE FERROMAGNETIC THEORIES. S. T. Lin and R. E. Ogilvie (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 34: 1372-3(Apr. 1963).

The intermetallic compound UFe_2 is ferromagnetic. A considerable number of magnetization isotherms were obtained from 200 down to 4.2°K with applied field up to 14,000 Oe. The Curie temperature was determined to be 172°K and the Bohr magneton number 1.02 per UFe_2 molecule. Several hysteresis loops at different temperatures were obtained. The coercive force, the remanence, and the loop area are all very small. These data were compared with existing theories of ferromagnetism. The $\sigma_{0T}/\sigma_{00} - T/T_c$ curve deviates considerably from the molecular field for curve $J = \frac{1}{2}$. The experimental data fit the $T^{\frac{3}{2}}$ law better than the T^2 law. Dyson's formula is valid below $T/T_c = 0.52$ while Bloch's formula is valid below $T/T_c = 0.35$. (auth)

37716 EFFECT OF COPPER PLATING ON THE VELOCITY OF PROPAGATION OF A NORMAL REGION IN NIOBIUM−25% ZIRCONIUM WIRE. Z. H. J. Stekly and E. Hoag (Avco-Everett Research Lab., Everett, Mass.). J. Appl. Phys., 34: 1376-7(Apr. 1963).

The propagation velocity of the normal region in a 0.010-in.-diam niobium−25% zirconium wire plated with 0 to 0.001-in. thickness of copper was measured with varying currents flowing through the wire in the presence of magnetic field perpendicular to the wire. The normal region was artificially started with a heater wire wrapped around the specimen. The copper plating results in a lower resistivity in the normal state as well as a higher thermal conductivity along the wire. Experimental results indicate that for thin plating thicknesses the thermal conductivity predominates over the lower resistivity resulting in a considerably higher velocity of propagation in a plated wire. (auth)

37717 MAGNETIZATION STUDIES ON SOME SUPERCONDUCTING TRANSITION METAL SOLUTIONS. Warren DeSorbo (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 34: 1378-9(Apr. 1963).

Magnetic induction measurements were carried out on a number of homogeneous solid solutions of the transition metals Nb, V, and Ta with solutes of column IV A and VI A. The hysteresis effects are large when the solute atoms are large correlating with increase in critical temperature, lattice parameter, and critical current. When the solute atom size is the same or smaller than the parent atom the hysteresis is small, similar to the magnetic behavior observed in all the alloys when in a finely divided state. This variation approaches that predicted by negative surface energy models. (auth)

37718 SOME RELATIONS BETWEEN SUPERCONDUCTING AND MAGNETIC PROPERTIES. P. G. de Gennes (Faculté des Sciences, Orsay, France) and G. Sarma. J. Appl. Phys., 34: 1380-5(Apr. 1963).

Effects of localized magnetic moments in a superconducting electron gas are discussed. The two electrons with up and down spin of a Cooper pair are submitted to different potentials, and the stability of the pair is reduced. Electrons interact via spin waves. Special attention is given to dilute magnetic alloys, antiferromagnetic systems, and to boundary effects between a ferromagnetic and a superconducting metal. (auth)

37719 INJECTION OF HIGH VELOCITY CHARGED PARTICLES INTO STRONG MAGNETIC FIELDS. Malcolm A. MacLeod and Ralph W. Waniek (Advanced Kinetics, Inc., Costa Mesa, Calif.). J. Appl. Phys., 34: 1415-23(May 1963).

Strong magnetic fields are useful in work with high velocity charged particles by virtue of their ability to rotate the particle momentum vector. The degree of usefulness is measured by the extent to which the desired rotations can be produced at the proper positions in the field. It is frequently necessary to inject charged particles into magnetic fields at points remote from these proper positions, in which case the injection parameters that enable the particles to reach these positions must be specified. For the production of gyromagnetic radiation in axially symmetric magnetostatic fields the proper positions correspond to the high field regions near the symmetry axis. The introductory study is concerned with delineating approximate injection parameter ranges that allow the particles to attain the regions of high magnetic field strength in the field whose axial variation is bell-shaped. The single-particle model is adopted, and the results of both qualitative and quantitative investigations are presented. A general formulation of the axially symmetric, magnetostatic field, forbidden-zone theory is given and the useful concept of the paraxial forbidden zones is introduced. This theory is then applied to obtain qualitative answers to the injection problem for the bell-shaped field for both zero and nonzero values of the angular momentum constant. Quantitative relations for the zero angular momentum constant case are obtained using the bell-shaped field paraxial tra-

jectories. A discussion of the limitations of the approximations employed is included. (auth)

37720 AN ELECTRODYNAMIC FOUCAULT PENDULUM. A. R. Shapiro and W. K. R. Watson (Motorola Research Lab., Riverside, Calif.). J. Appl. Phys., 34: 1553-6(May 1963).

The trajectories of a single charged particle trapped in an electrodynamic, quadrupolar-containment device are studied in a uniformly rotating coordinate system, in an attempt to simulate the behavior of a Foucault pendulum. (auth)

37721 APPLICATION OF QUANTIZED TRAPPED FLUX IN A SUPERCONDUCTING MEMORY. D. J. Dumin and J. F. Gibbons (Stanford Univ., Calif.). J. Appl. Phys., 34: 1566-7(May 1963).

The quantization of trapped flux in superconductors is used to construct a multiple-level memory cell with nondestructive readout. The construction of the memory cell and experimental data on its operating characteristics are presented. (C.E.S.)

37722 ELECTRON EJECTION FROM TANTALUM BY SINGLY IONIZED HELIUM. A. B. Laponsky (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 34: 1568(May 1963).

Measurements were made of the electron yield due to singly ionized He incident on Ta at 50–3000 ev. The electron yield as a function of He^+ energy and the electron energy distributions for incident energies of 100 and 3000 ev were presented. (C.E.S.)

37723 MICROWAVE FREQUENCY MULTIPLICATION BY HOT ELECTRONS. Karlheinz Seeger (Universität, Heidelberg). J. Appl. Phys., 34: 1608-11(June 1963).

An experimental study is made of microwave frequency multiplication observed in germanium at power levels of several kw. Using a fundamental frequency of 9.4 Bc, a third harmonic yield of about 1% was found. The data agree with calculations based on the observed deviations from Ohm's law. The anisotropy and the high frequency limit of the multiplication are calculated. (auth)

37724 INFLUENCE OF ION REFLECTION PROBABILITY ON POTENTIAL DISTRIBUTION IN LOW-PRESSURE THERMIONIC CONVERTERS. P. Mazur (Philips Labs., Irvington-on-Hudson, N. Y.). J. Appl. Phys., 34: 1611-14 (June 1963).

Some numerical results are presented as an example to show how, for certain boundary conditions, the voltage-current characteristic in low-pressure large-spaced gas diodes may give the appearance of saturating at a value of output current that is less than the saturated electron current from the emitter. The crucial parameter introduced that is mainly responsible for the phenomenon is f, defined as the probability that a returning ion reflects again as an ion after colliding with the emitter. (auth)

37725 SECONDARY-ELECTRON-EMISSION PHASE-ANGLE DISTRIBUTIONS IN HIGH-FREQUENCY MULTIPACTING DISCHARGES. A. Miller (New Mexico State Univ., University Park), H. Bartel Williams, and O. Theimer. J. Appl. Phys., 34: 1673-9(June 1963).

Numerical calculations of emission phase-angle distributions of electrons in a low-pressure, high-frequency electric discharge were carried out on a digital computer. An integral equation for the phase-angle distribution is developed, and the numerical techniques used for its solution are outlined. The distribution of multipacting electrons with respect to the parameter v/v_0, the ratio of impact velocity to emission velocity, was calculated for several situations. These distributions show distinctive peaks that explain the success of the assumption v/v_0 = constant in predicting the breakdown region. (auth)

37726 GAS-SOLID SUSPENSIONS AT HIGH TEMPERATURES. S. L. Soo (Univ. of Illinois; Urbana). J. Appl. Phys., 34: 1689-96(June 1963).

Thermal electrification of a gas-solid suspension and its electrical conductivity at high temperatures were studied. Possibilities of enhancing ionization and removal of electrons of a high temperature gas by solid particles were considered. (auth)

37727 MODULATED LANGMUIR PROBE CHARACTERISTICS. F. W. Crawford (Stanford Univ., Calif.). J. Appl. Phys., 34: 1897-1902(July 1963).

The presence of fluctuations in the discharge parameters introduces errors into Langmuir probe measurements. Previous work by Garscadden and Emeleus considered the effects of fluctuations in the individual parameters. A generalized small-amplitude theory of the effects of these fluctuations is given and also a large signal theory for single-frequency oscillations. The results of Garscadden and Emeleus can be deduced from these, but additional terms are predicted due to cross modulation occurring when the various fluctuations are correlated. The large signal theory was checked experimentally in a mercury-vapor discharge at a pressure of about 1 μ. Further experimental measurements with injected broad-band noise signals confirm certain features of the generalized theory. The errors caused by fluctuations are discussed and it is concluded that although electron temperatures may still be measured accurately in their presence, serious errors can be incurred in the measurement of electron saturation current and number density. (auth)

37728 SPACE-CHARGE-WAVE DECAY ALONG A SIGNAL-CURRENT-EXCITED MULTIVELOCITY BEAM. S. Bloom and B. Vural (Radio Corp. of America, Princeton, N. J.). J. Appl. Phys., 34: 2007-9(July 1963).

A previous analysis of noise propagation along a drifting electron beam with a half-Maxwellian distribution of velocities is specialized here to apply to the case of excitation by a signal current. The computed wave patterns that result are shown to be in quantitative agreement with those measured by Mihran. (auth)

37729 RELATING MEASUREMENTS ON SHORT SUPERCONDUCTING WIRES TO SOLENOID PERFORMANCE. C. H. Rosner and H. W. Schadler (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 34: 2107-8(July 1963).

A method for determining the critical current-field characteristics of short wire samples in superconducting solenoids is presented. The method consists in increasing the magnetic field and current simultaneously at constant but independent rates. In this way the actual field-current history of a wire at any point in a solenoid can be simulated. The critical current-field characteristics of a Nb–Zr wire determined by this method are presented. (C.E.S.)

37730 "COIL SIMULATION" TESTING OF NIOBIUM–TIN WIRE SAMPLES. C. H. Rosner, M. G. Benz, and D. L. Martin (General Electric Research Lab., Schenectady N. Y.). J. Appl. Phys., 34: 2108-9(July 1963).

The coil simulation test in which the current and field are increased simultaneously along predetermined straight current field lines is used to evaluate the superconducting critical current vs field characteristics of Nb–Sn wires in a solenoid. The critical current field characteristics are presented. (C.E.S.)

37731 BUBBLE FORMATION AT METAL–METAL INTERFACES AND ITS EFFECT ON THE SUPERCONDUCTING CHARACTERISTICS OF ALUMINUM–INDIUM LAMINATE FILMS. John L. Miles and P. H. Smith (Arthur D. Little, Inc., Cambridge, Mass.). J. Appl. Phys., 34: 2109-10(July 1963).

The critical temperature of aluminum-indium laminates was investigated in a vacuum of 10^{-6} Torr. The transition temperature was found to rise upon aging, indicating that a barrier was formed between the films. When the aluminum-indium laminate was removed from vacuum, bubbles started to form at the interface. It was suggested that water vapor oxidizes the top surface of the aluminum film and releases atomic hydrogen. The hydrogen diffuses into the aluminum and recombines at the interface to form molecular hydrogen that, being unable to diffuse away, forms bubbles. (C.E.S.)

37732 ELASTIC WAVE GENERATION BY ELECTRON BOMBARDMENT OR ELECTROMAGNETIC WAVE ABSORPTION. R. M. White (General Electric Co., Palo Alto, Calif.). J. Appl. Phys., 34: 2123-4(July 1963).

High-frequency elastic waves produced by electron bombardment or electromagnetic wave absorption are investigated. It is proposed that the incoming beam of electrons or radiant energy produces surface heating with consequent thermal expansion at the surface and propagation of the elastic disturbance. Several experiments supporting this hypothesis are presented. Stainless steel, copper, molybdenum, and Invar were used as the target materials. (C.E.S.)

37733 FRACTURE ON (110) PLANES IN LiF. S. Wiederhorn (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Appl. Phys., 34: 2125-34(Aug. 1963).

A study was made of (110) fracture in LiF using birefringence and etch-pit techniques. Fracture always occurred parallel to birefringence bands, and it is suggested that the stress of these bands aids (110) crack propagation. Surfaces formed by (110) fracture appear to be flat. If (100) steps are present, as suggested by Kuznetsov, they are less than 100 Å in height. By comparing etch-pit density data with birefringence data, it is estimated that only about one in twenty etch pits was due to single, unpaired dislocations. All the rest were probably caused by dipoles. (auth)

37734 HARDENING OF POTASSIUM CHLORIDE BY COLOR CENTERS. John S. Nadeau (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 34: 2248-53(Aug. 1963).

The flow stress of KCl crystals containing color centers was studied in a systematic way to determine which color centers produced significant hardening. The color centers were introduced both by additive coloring and by gamma irradiation. Annealing and optical bleaching techniques were used to alter the relative concentrations of defects. For a given concentration of electron excess centers (F, M, R, N, etc.), the irradiated crystals were about ten times harder than the additively colored ones. Possible models for the halogen defect responsible for this high hardness were considered and it was concluded that it must be an interstitial ion or atom. Annealing of additively colored crystals indicated that the colloid band was actually two overlapping bands centered at about 735 and 760 mμ. Prior to formation of these bands the crystals became about 40% harder than in the as-colored state indicating the presence of a coherent cluster of elementary defects. The flow stress decreased sharply upon appearance of the colloid bands. A similarly located though broader band was formed after prolonged optical bleaching. (auth)

37735 WORK FUNCTION AND THERMAL DESORPTION IN THE SYSTEM THORIUM-ON-RHENIUM. J. Anderson, W. E. Danforth, and A. J. Williams, III. (Franklin Inst., Swarthmore, Penna.). J. Appl. Phys., 34: 2260-5 (Aug. 1963).

The thermionic properties of rhenium and rhenium with an adsorbed layer of thorium atoms were investigated. The Richardson constants for rhenium were found to be ϕ = 4.85 ev and A = 66 A per cm^2-deg^2. The work function decreases with increasing thorium coverage σ to a minimum of 3.15 ev at $\sigma = 4.2 \times 10^{14}$ atoms per sq cm then rises to a constant value of 3.3 ev at $\sigma = 8 \times 10^{14}$ atoms per sq cm. A comparison with the system tungsten–thorium shows that: (a) ϕ_{min} occurs at the same surface density in both cases, (b) ϕ_{const} is attained at the same surface density in both cases, and this density is that of the atoms in a (100) plane of thorium metal, and (c) the values of ϕ_{const} are equal and different from that of bulk thorium by only 0.1 ev. On the basis of these regularities a model is proposed to explain the variation of ϕ with σ. The thermal desorption of the adsorbed atoms was studied at temperatures between 2203° and 2468°K. At low coverage the desorption rate per atom η_0, was found to be constant with coverage, and to obey the relation $\eta_0 = CT \exp(-\epsilon/kT)$ with $C = 4 \times 10^{10}$ sec^{-1} deg^{-1} and ϵ = 8.30 ev. The desorption rate increased for coverages between 0.05 and 0.5 monolayer and this increase agreed well with the predictions of a theory based on interactions among the adsorbed atoms. (auth)

37736 MULTIPLE CHARGE EXCHANGE OF AN ACCELERATED POSITIVE-ION BEAM IN A NEUTRAL GAS. P. Parzen (RCA, Princeton, N. J.). J. Appl. Phys., 34: 2322-6(Aug. 1963).

Charge exchange was suggested as a means of neutralizing the positive-ion beam in an ion propulsion engine. An important consideration is a study of the multiple charge-exchange process of a positive-ion beam in a neutral gas with an accelerating electric field. The problem is treated by solving the transport equation with a collision term corresponding to the charge-exchange process. Under certain simplifying assumptions, the transport equation is solved in the general case of an arbitrary spatial (one dimensional) variation of electric field and mean free path. Explicit results for the positive-ion particle density, thrust, and energy flux densities are obtained in the case of a uniform field. (auth)

37737 HARDENING OF KCl BY ELECTRON AND GAMMA IRRADIATION. W. A. Sibley and E. Sonder (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 34: 2366-70(Aug. 1963). (CONF-23-11)

Measurements of the flow stress and F-band coloration were made at room temperature on a number of different samples of KCl as a function of gamma and electron irradiation. The rate of increase of flow stress with irradiation is found to be greater (or smaller) in those samples and for those irradiation conditions for which the coloring rate is greater (or smaller). Moreover, the flow stress increase in any set of samples is proportional to the square root of the F-band absorption. The implication is that hardening is caused either by F centers or other defects whose production is related to the production of F centers. Since bleaching of F centers does not produce any softening, and since the magnitude of the hardening is of the order of magnitude to be expected for interstitial

type defects, the conclusion is drawn that the increase of flow stress due to irradiation of KCl is caused by interstitial clusters. (auth)

37738 ION-BOMBARDMENT ETCHING OF SYNTHETIC FIBERS. [PART] II. Franklin R. Anderson (Chemstrand Research Center, Inc., Durham, N. C.). J. Appl. Phys., 34: 2371-3(Aug. 1963).

Ion-bombardment etching of synthetic polymers is shown to result in an actual preferential removal of material in a manner similar to that producing the etch on natural polymers and on inorganic materials and metals. It is also shown that heat has little effect on the over-all etch pattern produced. In addition evidence is given relating the structures revealed by ion-bombardment etching and the low-angle x-ray periods which have been reported in the literature for polyethylene. (auth)

37739 ELECTRON SCATTERING AT SMALL ANGLES BY CARBON. N. H. Sarkar (Saha Inst. of Nuclear Physics, Calcutta). J. Appl. Phys., 34: 2379-82(Aug. 1963).

The differential and total elastic and inelastic scattering cross sections of the carbon atom were estimated theoretically with a more realistic charge distribution for the electrons in the K and L shells. The agreement of the several experimental results with present theoretical calculation is much better than with the existing theories of Lenz and Leisegang. For scattering by polystyrene latex particles, addition of the contribution of the hydrogen atoms in these particles results in an improvement of the agreement between theory and experiment. (auth)

37740 ELECTRON-BEAM PROBING OF A PENNING DISCHARGE. D. G. Dow. J. Appl. Phys., 34: 2395-2400 (Aug. 1963).

An electron beam probe was used to study the distribution of electric fields within the cold-cathode Penning discharge. Three basically different potential distributions were observed, in addition to the high pressure mode, which could not be studied with this technique. At the lowest pressures, the potential is roughly parabolic. As the pressure increases, a region develops in the center of the discharge, in which there is no electric field, that is, the potential profile is flat. Upon further increase in pressure, this central portion enlarges until it fills the majority of the discharge. At a pressure in the vicinity of 10^{-4} mm Hg the mode abruptly changes to one in which there is very little electric field throughout the discharge, although there are reasons to suspect a narrow region of high electric field near the anode. At still higher pressures (about 10^{-3} mm Hg) there is another abrupt change into the high pressure mode which acts essentially like a magnetically confined glow discharge. Due to instrumentation difficulties, and end effects of considerable magnitude, it was not possible to measure numerical values for the electric field and potential, but their qualitative behavior was plotted over a range of pressure, voltage, and magnetic field which is characteristic of the device. (auth)

37741 ION BOMBARDMENT OF SILICON IN A GLOW DISCHARGE. Hans Strack (Shockley Transistor, Palo Alto, Calif.). J. Appl. Phys., 34: 2405-9(Aug. 1963).

Silicon was bombarded with low-energy ions in a d-c glow discharge and simultaneously doped with phosphorus and boron. A simple theory describes the diffusion of substitutional elements in silicon influenced by ion bombardment. The distribution profile of phosphorus in 200 Ω-cm p-type silicon at a bombardment temperature of 820°C can be explained by assuming a diffusion coefficient of the form $D(x) = 3.6 \exp(-x/L) \times [\mu^2/h]$, with $L = 0.3\ \mu$ and x the distance from the instantaneous surface. L is interpreted as the diffusion length of excess vacancies created by the bombardment. The diffusion coefficient at the surface is higher by a factor of 10^5 than the one found in thermally activated diffusions. (auth)

37742 STUDY OF THE TRANSITION OF SMALL NIOBIUM–ZIRCONIUM SUPERCONDUCTING SOLENOIDS TO THE NORMAL STATE. Roger W. Boom and Louis D. Roberts (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 34: 2422-5(Aug. 1963). (TID-18279)

A preliminary study was made of the transition of small superconducting coils to the normal state. This transition was found to be fast compared with velocities found from measurements on short sample lengths of wire. The mode of dissipation of the field energy was studied; a relation between this and the critical current is indicated. (auth)

37743 FULL-PLANE THRESHOLD ENERGIES FOR CATHODE SPUTTERING OF METALS WITH Ar^+ IONS. Erich B. Henschke and Samuel E. Derby (Wright-Patterson Air Force Base, Ohio). J. Appl. Phys., 34: 2458-67(Aug. 1963).

Full-plane threshold energies at normal ion incidence of Ar^+ ions were determined for sixteen metals with a method of detection of deposits, using demountable sputtering tubes of different designs. Since in each case the target, immersed like a Langmuir probe in a high-density plasma, was bombarded by singly charged ions with a high ion current density under background conditions similar to those in Hg^+-ion sputtering tubes used for the determination of thresholds, the threshold data obtained for Ar^+-ion bombardment are comparable to those formerly published for sputtering with Hg^+ ions. This comparison discloses that threshold predictions for Ar^+ ions, formerly made by simply exchanging the mass of the Ar^+ ion for the mass of the Hg^+ ion in a threshold formula, are not correct at all. This result also implies that threshold formulas in which the interaction between the target atom and the impinging ion is only expressed by a mass factor containing the masses of the target atom and of the ion are not adequate to cover simultaneously the thresholds for different kinds of ions. The threshold data can be represented by a calculable factor f'. Applying a simplified threshold formula of cathode sputtering to the thresholds measured with Ar^+ ions, another representation of the data is possibly by the dissipation factors δ_{Ar^+} which are different from those for sputtering of the same metals with Hg^+ ions, indicating that the energy loss due to Debye waves during sputtering is different for different bombarding ions. The thresholds for Ar^+-ion sputtering are, in general, lower than those for Hg^+-ion bombardment; however, they obey the same law of periodicity seen in a plot vs atomic number, as formerly established for sputtering with Hg^+ ions. (auth)

37744 GROWTH OF HIGHLY PERFECT FLUORIDE SINGLE CRYSTALS FOR OPTICAL MASERS. H. Guggenheim (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 34: 2482-5(Aug. 1963).

A technique is described by which highly perfect single crystals of CaF_2, SrF_2, BaF_2, CdF_2, LaF_2, CeF_2, PrF_2, TbF_2, MgF_2, and ZnF_2 were prepared in a hydrogen fluoride atmosphere. Rare-earth-doped CaF_2, and SrF_2, LaF_2, cobalt-doped ZnF_2 and MgF_2, and nickel-doped MgF_2 were successfully used as optical masers. These crystals were

free of light scattering and revealed no strain pattern when viewed through crossed polarizers. (auth)

37745 HILLOCKS ON SPUTTERED Ge SURFACES. D. Haneman and M. F. Chung (Univ. of New South Wales, Sydney). J. Appl. Phys., 34: 2488-9(Aug. 1963).

Evidence for the formation of hillocks on sputtered germanium surfaces was obtained by bombarding low-index faces of single crystals with argon ions under various conditions. In all cases the argon was ionized by a hot filament gun, at pressures from 10^{-2} to 10^{-3} mm. Bombarding energies ranged from 300 to 500 ev at current densities up to 0.5 m amp/cm^2. (R.E.U.)

37746 MASS ANALYSIS OF SPUTTERED PARTICLES. A. J. Smith, L. A. Cambey, and D. J. Marshall (Nuclide Corp., State College, Penna.). J. Appl. Phys., 34: 2489-90 (Aug. 1963).

Mass analyses of sputtered particles are obtained with a mass spectrometer. Analyses of both neutrals and sputtered ions were carried out by use of a synchronous source-detector system. A copper target was bombarded with 2-kev argon ions, and the resulting mass spectrum is shown. (R.E.U.)

37747 EFFECT OF DAUTHTER Rb^{85} ON THE CHARACTERISTICS OF A THERMIONIC DIODE CONTAINING Kr^{85}. R. Forman and J. A. Ghormley (Union Carbide Corp., Parma, Ohio). J. Appl. Phys., 34: 2498-9 (Aug. 1963).

It was found that the current-voltage characteristic curve of thermionic diodes shifted with time toward more negative anode voltages. The constancy of the cathode emission suggested that the effects were to be attributed to a lowering of the anode work function by deposition of Rb^{85}, the decay product of the Kr^{85} contained in the diode. (R.E.U.)

37748 LOW-VOLTAGE GLOW DISCHARGE IN ATMOSPHERIC PRESSURE ARGON WITH SMALL ADDITIONS OF CESIUM OR POTASSIUM. J. C. Ralph (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). J. Appl. Phys., 34: 2499-2500(Aug. 1963).

Electric conductivity measurements were carried out between movable tantalum disks in thermal equilibrium with argon plus cesium or potassium in the temperature range 750 to 1000°C at pressures up to 1.7 atm. The argon was passed slowly through a vapor trap containing the cesium or potassium at the required vapor pressure and into a tube furnace. Possible application is made to magnetohydrodynamic generators. (R.E.U.)

37749 REVIEW OF ENERGY CONVERSION METHODS USING RADIOISOTOPES. J. L. Craston (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Brit. Interplanet. Soc., 19: 105-9(July-Aug. 1963).

The characteristics of radioisotopes are outlined and their potential hazards are indicated. Methods of converting the disintegration energy of radioisotopes into electrical power can be classified into two main groups, which can be subdivided into a total of five classes. Progress in each class is reviewed. (auth)

37750 PERTURBATION THEORY AND THE HELLMANN-FEYNMAN THEOREM. Robert Yaris (Univ. of Minnesota, Minneapolis). J. Chem. Phys., 39: 863-7 (Aug. 15, 1963).

By using the Hellmann-Feynman theorem in conjunction with an operator formulation of perturbation theory it is shown that, while for a general Hamiltonian an energy derivative is determined only to order n by an mth-order wavefunction, for a restricted class of systems it is determined to order $n + 1$, and by restricting the class somewhat energy derivatives to order $2n + 1$ can be obtained. The example of the force between two atoms interacting through dispersion type forces is briefly discussed. (auth)

37751 NATURAL EXPANSIONS OF EXACT WAVEFUNCTIONS. III. THE HELIUM-ATOM GROUND STATE. Ernest R. Davidson (Univ. of Washington, Seattle). J. Chem. Phys., 39: 875-80(Aug. 15, 1963).

A wavefunction similar to the Kinoshita function was analyzed into natural orbitals. As it was for the hydrogen molecule, the first natural orbital for helium is very nearly the SCF function. The first three natural orbitals describe the atom quite well. These three terms give an energy of -2.8974 hartrees and an overlap with the exact wavefunction of 0.99979. Beyond these three terms, the natural expansion converges slowly with many terms required to even approximately fit the cusp in the correlation hole. (auth)

37752 PHOTO-IONIZATION EFFICIENCY CURVES. MEASUREMENT OF IONIZATION POTENTIALS AND INTERPRETATION OF FINE STRUCTURE. A. J. C. Nicholson (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Chem. Phys., 39: 954-61(Aug. 15, 1963).

A method is described for measuring photo-ionization efficiency (PE) curves over the energy range 9–14 ev. The method is experimentally easier than measuring the photo-ionization cross section and gives essentially the same result. PE curves are given for Xe, O_2, and NO and first ionization potentials are determined; Xe, 12.129 ± 0.002 ev; O_2, 12.065 ± 0.003 ev; and NO, 9.250 ± 0.005 ev. It was established that steps in the PE curve of NO give a quantitative measure of the energies of the vibrational levels in the NO^+ ion and that peaks in the curves of all three gases correspond to neutral levels that auto-ionize. The probability laws for ionization and auto-ionization are discussed. (auth)

37753 DISSOCIATIVE CHARGE TRANSFER IN $He^+ - O_2$ AND $He^+ - N_2$ COLLISIONS. R. F. Stebbings, A. C. H. Smith, and Helmut Ehrhardt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Chem. Phys., 39: 968-71(Aug. 15, 1963).

Cross sections for charge transfer between He^+ ions and molecules of nitrogen and oxygen were determined within the energy range 100–7700 ev. A mass spectrometer was used to analyze the secondary ions, and the dissociative and nondissociative charge-transfer cross sections were separately determined. The observations show that in both reactions the major contribution to the total charge-transfer cross section comes from collisions involving dissociation. (auth)

37754 ZERO-FIELD SPLITTING IN $3d^5$ IONS. A. S. Chakravarty (Columbia Univ., New York). J. Chem. Phys., 39: 1004-11(Aug. 15, 1963).

The origin of the zero-field splittings of the orbitally nondegenerate ground states of the transition metal ions ($3d^3$, $3d^5$, and $3d^8$ solutes) was studied on the assumption that the splittings are due to the combined action of an electric field gradient and the spin–spin interaction. A relation between the splitting parameters D and E of the conventional spin Hamiltonian and the field gradients $q_{||}$ and $\eta q_{||}$, respectively, was deduced on the above basis using hydrogenic wavefunctions and d → d, d → g, and d → s excitations. A reasonably good agreement with the

splitting was obtained for Mn^{2+} in corundum but an apparent disagreement has been found for Fe^{3+} in Al_2O_3, considering the known values of the field gradients in these cases. For Cr^{3+} (d^3 solute) and Ni^{2+} (d^8 solute) in corundum, the major sources of splitting seem to be the spin–orbit interaction and the distortion of the ground state wavefunctions due to covalent π bonding and not the spin–spin interaction. The cause of the apparent disagreement for Fe^{3+} in Al_2O_3 is discussed. A definite understanding of the cause of the zero-field splittings in the transition metal ions depends on more accurate knowledge of the field gradients acting on the ions in different crystalline environments. (auth)

37755 POTENTIAL CURVE FOR THE $^2\Sigma_u^+$ STATE OF H_2^-. Howard S. Taylor (Univ. of Southern California, Los Angeles and California Inst. of Tech., Pasadena) and F. E. Harris. J. Chem. Phys., 39: 1012-16(Aug. 15, 1963).

The $^2\Sigma_u^+$ state of H_2^- is shown to lie in the continuum of $H_2X^1\Sigma_g + e$. This result is contrary to a number of previously reported results. (auth)

37756 X-RAY AND ELECTRICAL CONDUCTIVITY STUDY OF THE FLUORITE PHASE IN THE SYSTEM ZrO_2–CaO. T. Y. Tien and E. C. Subbarao (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys., 39: 1041-7 (Aug. 15, 1963).

In the ZrO_2–CaO system cubic solid solutions of the fluorite-type structure are formed between 12 and 22 mole % CaO for specimens fired at 2000°C and subsequently quenched from 1400°C. The lattice parameter increased linearly from 5.125 to 5.144 Å with increasing CaO content. Results of x-ray diffraction intensity studies favored the oxygen-ion vacancy model over the cation interstitial model for the solid solutions. As the CaO content was increased from 13 to 20 mole %, the electrical conductivity at 1000°C decreased from 5×10^{-2} to 6×10^{-3} Ω^{-1} cm^{-1} and the activation energy increased from 1.11 to 1.35 ev. Specimens heated at 1000°C for one week showed extra x-ray diffraction lines. The data coupled with accompanying changes in electrical conductivity are discussed in terms of an order-disorder transition. (auth)

37757 FLUORESCENCE SPECTRAL STUDY OF WAVELENGTH SHIFTERS FOR SCINTILLATION PLASTICS. Stanley R. Sandler and K. C. Tsou (Borden Chemical Co., Philadelphia). J. Chem. Phys., 39: 1062-7 (Aug. 15, 1963).

An investigation of the fluorescence spectra of a series of 1,3,5-triaryl-2-pyrazoline indicated that substituents in the 3-phenyl ring shifted the fluorescence emission wavelength linearly with Brown's σ_p^+. On the basis of this evidence the excited state is thought to have a partial positive charge located on carbon-3 of the pyrazoline ring. The shift in the absorption spectral bands of 1,3,5-triphenyl-2-pyrazoline with concentration is presented as evidence of a dimer or an associated complex. The fluorescence quenching at higher concentrations may be due to the energy dissipating effect of the dimers or complexes. The high extinction coefficient of the uv maximum and yet the similarity of the fluorescence intensity of 4,4′-bis-[5-(1,3-diphenyl-2-pyrazolinyl)] benzene to 1,3,5-triphenyl-2-pyrazoline is explained on the basis of an internal quenching mechanism. The efficiency of the two compounds as wavelength shifters in plastic scintillators is approximately equal. (auth)

37758 IONIZATION ON TUNGSTEN SINGLE-CRYSTAL SURFACES. F. L. Reynolds (Univ. of California, Berkeley). J. Chem. Phys., 39: 1107-14(Aug. 15, 1963).

Surface ionization of atomic beams of strontium or calcium from the [110] and the [111] directions of tungsten was studied mass-spectrometrically. Results consistent with the Saha-Langmuir relation indicate that the method is applicable for the determination of first ionization potentials or work functions. A value for the work function of the [110] direction is 5.41 ± 0.04 ev. A value for the [111] direction of tungsten is 4.49 ± 0.04 ev. (auth)

37759 QUADRUPOLE ANTISHIELDING IN THE RARE EARTHS. Johan Blok and D. A. Shirley (Univ. of California, Berkeley). J. Chem. Phys., 39: 1128-9(Aug. 15, 1963). (UCRL-10844)

Using recently determined quadrupole coupling constants for La^{3+} and Eu^{3+} in two ionic lattices and the known values of the crystal-field parameter V_2^0 for other rare earths in these lattices, contributions to the field gradient at the nucleus arising from polarization of the closed inner electron shells, by the crystal field, were estimated for all the rare earths. The estimates were tested by nuclear orientation experiments on Eu^{154}, Gd^{159}, and Lu^{177} in cerium magnesium nitrate lattices and on Gd^{159} and Lu^{177} in crystals of neodymium ethylsulfate. It was found that the ratio γ_N/γ_E has an average value of about −400 in the ethylsulfate and −120 in the double nitrate lattice. In addition γ_N is negative. (P.C.H.)

37760 LOW-FREQUENCY MOLECULAR MOTIONS IN POLYETHYLENE. G. J. Safford, H. R. Danner, and H. Boutin (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 39: 1134-5(Aug. 15, 1963). (BNL-6907)

The energy distribution of initially cold neutrons (E_0 = 0.005 ev) scattered at 90° from a highly crystalline sample of polyethylene was measured. A sharp rise in the distribution at 5.2 Mev, followed by a decrease at lower energies, constitutes the elastic scattering from the sample and its shape reflects the energy distribution in the incident beam. The distribution above 5.2 Mev is proportional to the differential scattering cross section for neutron energy gain and is related, albeit in an indirect way, to the frequency distribution of the molecular motions in the sample. An acoustic mode corresponding to ν_9 was observed in good agreement with theory. Partially resolved peaks at 720 and 1050 cm^{-1} correlate well with the two lowest optical modes, ν_8 and ν_4. The broad peak centered at 1350 cm^{-1} is associated with the unresolved contributions of the higher optical modes ν_2, ν_3, and ν_7. (P.C.H.)

37761 CANONICAL FORM OF THE COVARIANT FREE-PARTICLE EQUATIONS. A. Chakrabarti (Ecole Polytechnique, Paris). J. Math. Phys. (N. Y.), 4: 1215-22(Oct. 1963).

The canonical form of the covariant equations for free particles of nonzero rest mass is proposed to be $[(p^\mu p_\mu)^{1/2} - \kappa]\psi = 0$, instead of $[\gamma^0(p^2 + \kappa^2)^{1/2} - p^0]\psi = 0$, as suggested by Foldy. The connection of this representation with the usual forms of the Dirac and the Klein–Gordon equations is discussed, each feature being compared with the corresponding one in Foldy's case. The case of the Dirac equation is treated in some detail. A study of the infinitesimal operators of the Poincaré group and the transformation properties of the wavefunction and the polarization operator in this representation indicates that the choice of operators and the definition of spin states adopted by Iu. M. Shirokov in his study of the Poincaré group corresponds directly to the representation and the canonical form proposed, rather than that proposed by Foldy. It is also shown that the proposed canonical form corresponds to Wigner's unitary representation of the Poincaré group in terms of the little group of (κ, 0, 0, 0) (for $\kappa > 0$). (auth)

37762 RELATIVISTIC POSITION OPERATOR FOR FREE PARTICLES. A. Chakrabarti (Ecole Polytechnique, Paris). J. Math. Phys. (N. Y.), 4: 1223-8(Oct. 1963).

Certain definitions and derivations for the relativistic center of mass are considered and are related to the position operator corresponding to the representation proposed in a previous paper. It is shown that the classical definition of Pryce has a more direct correspondence with the proposed representation than the Foldy–Wouthuysen representation, in spite of the fact that Pryce's particular method of symmetrization leads to the latter. In the process of derivation, the points of view of Synge, Pryce, and Shirokov are compared, and the expressions for the velocity and the intrinsic angular momentum corresponding to the different definitions are given. The operator is compared with that of Newton and Wigner for the case of spin $\frac{1}{2}$. (auth)

37763 LOCAL COMMUTATIVITY AND THE ANALYTIC CONTINUATION OF THE WIGHTMAN FUNCTION. Yukio Tomozawa (Istituto Nazionale di Fisica Nucleare, Pisa, Italy). J. Math. Phys. (N. Y.), 4: 1240-52(Oct. 1963).

It is proved that the analytic continuation of the Wightman function, the vacuum expectation value of the product of field operators, due to local commutativity is single-valued in the union of the extended tubes which correspond to the Wightman functions obtained by permuting the order of the field operators in the product, and that the extended tubes, the union of them, and the intersection of any two, are simply connected. (auth)

37764 ENERGY-DEPENDENT BOLTZMANN EQUATION IN PLANE GEOMETRY. Roman J. Bednarz and Janusz R. Mika (Inst. of Nuclear Research, Warsaw). J. Math. Phys. (N. Y.), 4: 1285-92(Oct. 1963).

The general procedure for solving the energy-dependent Boltzmann equation in plane geometry is presented. The particular solutions are found, and then it is proved that the general solutions can be formed by superposition of particular solutions. As an illustration, the fully degenerate kernel is considered in detail, and a solution in a closed form is obtained. (auth)

37765 COMPUTER STUDIES OF ENERGY SHARING AND ERGODICITY FOR NONLINEAR OSCILLATOR SYSTEMS. Joseph Ford and John Waters (Georgia Inst. of Tech., Atlanta). J. Math. Phys. (N. Y.), 4: 1293-1306 (Oct. 1963).

Weakly coupled systems of N oscillators are investigated using hamiltonians of the form $H = \frac{1}{2}\sum_{k=1}^{N}(p_k^2 + \omega_k^2 q_k^2) + \alpha \sum_{j,k,l=1}^{N} A_{jkl} q_j q_k q_l$, where the A_{jkl} are constants and where α is chosen to be sufficiently small that the coupling energy never exceeds some small fraction of the total energy. Starting from selected initial conditions, a computer is used to provide exact solutions to the equations of motion for systems of 2, 3, 5, and 15 oscillators. Various perturbation schemes are used to predict, interpret, and extend these computer results. In particular, it is demonstrated that these systems can share energy only if the uncoupled frequencies ω_k satisfy resonance conditions of the form $\Sigma n_k \omega_k \lesssim \alpha$ for certain integers n_k determined by the particular coupling. It is shown that these systems have N normal modes, where a normal mode is defined as motion for which each oscillator moves with essentially constant amplitude and at a given frequency or some harmonic of this frequency. These systems are shown to have, at least, one constant of the motion, analytic in q, p, and α, other than the total energy. Finally, it is demonstrated that the single-oscillator energy distribution density for a 5-oscillator linear and nonlinear system has the Boltzmann form predicted by statistical mechanics. Thus, these nonlinear systems are shown to have many features in common with linear systems. In particular, it is unlikely that they are ergodic. From the standpoint of statistical mechanics, it is argued that this lack of ergodicity may be a welcome feature. (auth)

37766 CONVERGENCE OF FUGACITY EXPANSIONS FOR FLUIDS AND LATTICE GASES. Oliver Penrose (Yeshiva Univ., New York). J. Math. Phys. (N. Y.), 4: 1312-20(Oct. 1963).

Upper and lower bounds are obtained for R(V), the radius of convergence of the Mayer expansion $V\Sigma_l b_l(V) z^l$ expressing the logarithm of the classical grand partition function for a finite volume V as a power series in the fugacity z. The particles in V interact only through two-body forces whose potential $\varphi(r)$ satisfies $s^{-1}\Sigma_{i<j\leq s}\varphi(x_i - x_j) \geq \text{const} \equiv -\Phi$ for all $s, x_1 \ldots x_s$. The bounds are $|e^{1+2\Phi/kT}\int |e^{-\varphi(r)/kT} - 1|\, d^3r|^{-1} \leq R(V) \leq |e^{\Phi/kT} l/(l-1) b_l(V)|^{1/(l-1)}$ for any $l \geq 2$. For lattice gases the integral becomes a sum. The upper bounds, obtained from the theory of entire functions, include a subsequence converging to R(V) as $l \to \infty$. The lower bound is obtained by using the Kirkwood–Salsburg integral equation to calculate upper bounds on the $b_l(V)$'s and the coefficients in the fugacity expansions of the s-particle distribution functions. For hard-core potentials some of these bounds can be strengthened. For nonnegative potentials, $1/2|b_2(V)|$ is an extra upper bound on R(V). The radius of convergence of the infinite-volume series $\Sigma\, b_l z^l$ is shown to be at least $\lim_{V\to\infty} R(V)$, with equality for nonnegative potentials. (auth)

37767 REMARKS ON THE COMBINATORIAL APPROACH TO THE ISING PROBLEM. P. N. Burgoyne (Univ. of California, Berkeley). J. Math. Phys. (N. Y.), 4: 1320-6(Oct. 1963).

A new proof is given of a certain conjecture due to Feynman. This conjecture relates graphs and paths on a lattice and was first proved by Sherman. It is the key step in a particular method of obtaining Onsager's formula for the partition function of the two-dimensional Ising model. (auth)

37768 APPROXIMATE EVALUATION OF FEYNMAN FUNCTIONAL INTEGRALS. Gerald Rosen (Southwest Research Inst., San Antonio). J. Math. Phys. (N. Y.), 4: 1327-33(Oct. 1963).

By considering a new set of functions for the integration domain, Feynman's functional-integral representation of the propagation kernel is evaluated approximately for values of the time that are not too large. The approximation theory is applied to systems of uncoupled and strongly coupled oscillators. (auth)

37769 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON MAGNETISM AND CRYSTALLOGRAPHY, KYOTO, SEPTEMBER 25-30, 1961. I. MAGNETISM. J. Phys. Soc. Japan, 17: Suppl. B-I, 1-718 (Mar. 1962).

Papers were presented on the theory of magnetization processes and magnetic behavior of crystals. Other topics included nuclear magnetic resonance in metals, Mössbauer effect in metals and alloys, anisotropy and relaxation in ferrites and metals, yttrium iron garnets and ferromagnetic resonance, ferromagnetic and antiferromagnetic resonance, paramagnetic resonance and relaxation, magnetism at low temperature, domain structures, magnetic thin films, technical magnetization, and physical problems

of rock magnetization. Separate abstracts are prepared for 20 of the 187 papers presented. Four papers were previously abstracted in NSA. (C.E.S.)

37770 THEORY OF THE EFFECTS OF ANISOTROPY ON SPIRAL SPIN-CONFIGURATIONS WITH APPLICATION TO RARE EARTH METALS. T. A. Kaplan (Massachusetts Inst. of Tech., Lexington). J. Phys. Soc. Japan, 17: Suppl. B-I, 3-4(Mar. 1962).

Some effects of anisotropy on spirals are studied by considering a spin-hamiltonian that includes exchange forces, crystal field and dipolar forces. It is shown that the ferromagnetic spiral (FS) observed in Er at low temperatures can be the ground state provided terms of at least fourth order in the spin variables are present in the hamiltonian. Furthermore, the observed cone angles can be realized with anisotropy forces much smaller than the exchange forces. The spin wave spectrum for the FS has the properties that $\omega(k)$ is linear in k for small k, and there are two distinct branches, as contrasted with the case of simple spirals. For high temperatures, calculations are made on the basis of the molecular field approximation. It is shown that a small easy axis anisotropy implies that at the highest transition temperature, T_c, the ordered spin configuration is a static longitudinal spin wave as observed in Er. As T decreases below T_c, the amplitude of this wave grows in order $(T_c - T)^{1/2}$, with odd harmonics appearing in order $(T_c - T)^{3/2}$. The transverse components remain zero until a second transition temperature is reached, below which they begin to order. The observed thermal variation in wavelength can be accounted for in Er specifically by the dipolar forces. (auth)

37771 MAGNETIC ORDERING IN THE FERROMAGNETIC RARE-EARTH METALS. Kei Yosida and Hirosi Miwa (Tokyo Univ.). J. Phys. Soc. Japan, 17: Suppl. B-I, 5-10(Mar. 1962).

The effect of the anisotropy energy on the screw structure is investigated concerning the magnetic structure of heavy rare-earth metals. In the high temperature region near the Néel temperature the free energy of the spin system is calculated and it is shown that if the preferred direction of the spin is in the c plane, a usual screw structure appears, whereas if the anisotropy energy makes the preferred direction of the spin parallel to the c axis, only the z-component oscillation first appears and then the oscillation of x or y component appears at a lower temperature. The change of the period of the screw and the various magnetic transitions observed in dysprosium, holmium and erbium are also discussed. (auth)

37772 EXCHANGE POLARIZATION AND THE MAGNETIC BEHAVIOR OF TRANSITION METAL AND RARE EARTH IONS. A. J. Freeman (Materials Research Lab., Ordnance Materials Research Office, Watertown, Mass.) and R. E. Watson. J. Phys. Soc. Japan, 17: Suppl. B-I, 15-19(Mar. 1962).

Investigations were carried out for the contribution of paired electrons to the magnetic properties of solids utilizing the spin or exchange polarization mechanism in the Hartree-Fock formalism. Three different physical properties were studied, each distinguished by the particular region in which the spin density predominates: the magnetic interaction of a rare earth ion with its neighbors and with its own conduction electrons. The contribution of the core polarization to the effective magnetic fields observed by Mössbauer, NMR, EPR and specific heat measurements and to the observed Knight shifts for systems with unpaired s and d (or f) electrons. The contribution of the paired electrons to the magnetic scattering of neutrons by transition metal and rare earth ions. (auth)

37773 RECENT THEORETICAL WORK ON MAGNETISM AT HARWELL. W. Marshall (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phys. Soc. Japan, 17: Suppl. B-I, 20-2(Mar. 1962).

Some of the recent theoretical research on magnetism at the Atomic Energy Research Establishment, Harwell, is briefly reviewed. Topics discussed are: the validity of the unrestricted Hartree-Fock method; the polarization of the conduction electrons in ferromagnets; the neutron form factor for Ni^{2+} salts, and correction terms for the transferred hyperfine interaction in magnetic complexes. (auth)

37774 NUCLEAR MAGNETIC RESONANCE IN RARE EARTH INTERMETALLIC COMPOUNDS. A. C. Gossard, V. Jaccarino, and J. H. Wernick (Bell Telephone Labs., Murray Hill, N. J.). J. Phys. Soc. Japan, 17: Suppl. B-I, 88-91(Mar. 1962).

The nuclear magnetic resonance (NMR) of nuclei of nonmagnetic ions in rare earth intermetallic compounds revealed that an appreciable polarization of the conduction electrons exists. A phenomenological interpretation of these results was given assuming an exchange interaction $FS \cdot s$ to exist between the spins of the rare earth ions and the conduction electrons. A surprising result is that, though of the proper magnitude, $F < 0$. A further study of these effects was realized by an investigation of the broadening of the NMR in magnetically dilute compounds (e.g., $Gd_{0.001}La_{0.999}Al_2$) assuming that the above exchange interaction induces an oscillatory radial dependence of the conduction electron polarization. These results are consistent with the magnitudes of the effects observed in the magnetically dense compounds. (auth)

37775 MAGNETIC PROPERTIES OF RARE EARTH ALUMINUM COMPOUNDS WITH $MgCu_2$ STRUCTURE. H. J. Williams, J. H. Wernick, E. A. Nesbitt, and R. C. Sherwood (Bell Telephone Labs., Murray Hill, N. J.). J. Phys. Soc. Japan, 17: Suppl. B-I, 91-5(Mar. 1962).

The magnetic moments of some RAl_2 (R = rare earth element) cubic Laves phase compounds were measured at temperatures from 1.4 to 300°K. The measurements indicate that the spin moments of the rare earth ions are coupled ferromagnetically. The Curie points of the RAl_2 compounds are found to be uniformly higher than the corresponding Laves compounds, ROs_2, RIr_2 and RRu_2. Solid solutions of some of the compounds were also investigated. For example, in the $Gd_xPr_{(1-x)}Al_2$ compounds, the magnetic moments of the Gd ions are antiparallel to those of the Pr ions because J is antiparallel to S in the ground state of the Pr ion. Compensation points were observed in this system. (auth)

37776 SUPERCONDUCTIVITY AND FERROMAGNETISM. B. T. Matthias (Bell Telephone Labs., Murray Hill, N. J.). J. Phys. Soc. Japan, 17: Suppl. B-I, 104-5 (Mar. 1962).

Mechanisms responsible for superconductivity are discussed. Three groups of superconductors are considered: transition elements and their combinations, non-transition elements and their combinations, and compounds between transition and non-transition elements. It is proposed that superconductivity cannot coexist with the ferromagnetism of the transition elements because of the strong s-d interaction. (C.E.S.)

37777 THE ISOMER SHIFT IN Fe^{57}. L. R. Walker, G. K. Wertheim, and V. Jaccarino (Bell Telephone Labs.,

Murray Hill, N. J.). J. Phys. Soc. Japan, 17: Suppl. B-I, 121-2(Mar. 1962).

The Fe^{57} 14-kev γ ray was investigated in experiments in which the emitting nuclei were in stainless steel and the absorbing nuclei in a variety of divalent and trivalent iron compounds or in iron dissolved in various metals. The measured shifts in the Mössbauer absorption line furnish a measure of the s-electron density at the absorber nuclei relative to that at the nuclei in stainless steel. The observed shift implied that the prevalent configuration was very near $3d^74s^1$. (C.E.S.)

37778 STUDIES OF THE INTERNAL FIELDS ACTING ON NUCLEI IN FERRIMAGNETIC AND PARAMAGNETIC SOLIDS, USING RECOIL-FREE RESONANCE ABSORPTION (MÖSSBAUER EFFECT). R. Bauminger, S. G. Cohen, A. Marinov, and S. Ofer (Hebrew Univ., Jerusalem). J. Phys. Soc. Japan, 17: Suppl. B-I, 123-4(Mar. 1962).

Recoil-free gamma ray absorption spectra were observed in ferrimagnetic and paramagnetic solids containing nuclei of Fe^{57} and Dy^{161}, using radioactive sources of Co^{57} and Tb^{161}. The hyperfine Zeeman splittings in ferrimagnetic materials permit a determination of the effective magnetic field (H_{eff}) at the nuclei. H_{eff} at Fe^{57} nuclei in yttrium iron garnet, dysprosium iron garnet and in some spinel ferrites were measured at 300 and 85°K. Measurements on Fe_3O_4 confirm Verwey's hypothesis of a fast exchange between ferrous and ferric ions in the octahedral sites above the transition temperature. H_{eff} at Dy^{161} in dysprosium iron garnet was found to be 3.5×10^6 oe at 85°K and 7.5×10^5 oe at 300°K and is proportional to the Dy sub-lattice spontaneous magnetization. A large temperature dependent quadrupole interaction in DIG was observed, which is ascribed to an effective electric field gradient at the Dy nuclei produced by the partially aligned orbitals of the 4f electrons, and thus correlated with the spontaneous magnetization. (auth)

37779 THE MÖSSBAUER EFFECT IN SOME IRON COMPOUNDS. K. Ôno (Tokyo Univ.), Y. Ishikawa, A. Ito, and E. Hirahara. J. Phys. Soc. Japan, 17: Suppl. B-I, 125-9(Mar. 1962).

Magnetic properties of Fe_3O_4, αFe_2O_3, $FeS_{1.00}$, $FeS_{1.05}$, and Fe_3Al were investigated with the method of the Mössbauer effect. (auth)

37780 MÖSSBAUER STUDY OF $FeTiO_3$ AND ITS SOLID SOLUTIONS WITH αFe_2O_3. G. Shirane and S. L. Ruby (Westinghouse Electric Corp., Pittsburgh). J. Phys. Soc. Japan, 17: Suppl. B-I, 133-5(Mar. 1962).

The solid solutions $(1-x)FeTiO_3$-xFe_2O_3 exhibit strong ferrimagnetic moments for the compositions $x < 0.6$, where the Fe and Ti ions are ordered in the alternate (111) layers. The anomaly revealed by the Mössbauer measurements is that the ferrimagnetic phase consists of ferrimagnetic clusters surrounded by paramagnetic media. The size of these clusters decreases with increasing temperature or increasing local concentration of Ti. The isomer shift of $FeTiO_3$ is 1.2 mm/sec at room temperature as expected for Fe^{2+}. At 20°K, the hyperfine field was found to be 70 koe, considerably smaller than the expected value for Fe^{2+}. (auth)

37781 INTERMETALLIC COMPOUNDS OF IRON AND COBALT WITH GADOLINIUM. William M. Hubbard and Edmond Adams (Naval Ordnance Lab., Silver Spring, Md.). J. Phys. Soc. Japan, 17: Suppl. B-I, 143-6(Mar. 1962).

Thermomagnetic and x-ray measurements on the system gadolinium-cobalt indicate that antiferromagnetic interactions exist in agreement with the work of Nesbitt et al. Only two intermetallic compounds, $GdFe_2$ and $GdFe_5$, were found in the gadolinium-iron system instead of the seven reported by Vickery et al. Magnetic measurements on the compounds $GdCo_5$, $GdFe_5$, and $Gd(Co_xFe_{1-x})_5$ indicate that the spin arrangements change from Gd↑ 5Co↓ to Gd↑ 2Fe↓ 3Fe↓ as x varies from 1 to 0. (auth)

37782 MAGNETIC PROPERTIES OF αFe_2O_3 SINGLE CRYSTALS. S. T. Lin (Massachusetts Inst. of Tech., Cambridge). J. Phys. Soc. Japan, 17: Suppl. B-I, 226-30 (Mar. 1962).

From the study of comprehensive magnetic measurements of isotherms, remanent magnetization, and hysteresis along different directions of αFe_2O_3 single crystals of both natural and synthetic origin, it is indicated that the magnetic properties of both kinds of material are qualitatively about the same but quantitatively different. The inherent weak ferromagnetism of the material can be observed not only in the (111) plane above the Morin transition but also along the [100] direction below the transition. For the Elba crystal a graphical representation of the ferromagnetic state was constructed to show the direction, the magnitude, and the turning of the remanence vector between the (111) plane and the [111] axis in the transition region. In order to account for all the experimental facts it is proposed that the slightly unequal sublattice moments form canted antiferromagnetic domains and the domain axes in turn form equilateral triangular arrangement. (auth)

37783 NEUTRON DIFFRACTION INVESTIGATION OF THE MAGNETIC AND STRUCTURAL PROPERTIES OF NEAR-STOICHIOMETRIC IRON SULFIDE. Joseph T. Sparks, Warren Mead, and Ted Komoto (Univ. of California, Livermore). J. Phys. Soc. Japan, 17: Suppl. B-I, 249-52 (Mar. 1962). (UCRL-6580)

The temperature dependent magnetic behavior and lattice changes in $Fe_{0.996}S$ were investigated simultaneously in the vicinity of the α-transition (T_α = 142°C) by means of powder neutron diffraction. The accurate determination of the shifts in the (100) and (102) nuclear peak positions with decreasing temperature shows that the C-axis lattice parameter abruptly increases by 1% and that the A-axis parameter abruptly decreases by 0.5% at T_α. The superlattice is also observed to form at this temperature and, in addition, the powder susceptibility exhibits an anomalous decrease of about 50% here. The behavior of the magnetic reflections shows that a rotation of the magnetic moments out of the basal plane begins at 185°C and ceases at 160°C, having rotated to within approximately 20° of the C-axis. At T_α, the g-factor abruptly increases about 25% as a result of the lattice distortion and then, with decreasing temperature, the moments resume their rotation toward the C-axis. (auth)

37784 MAGNETIC RELAXATION IN SILICON IRON UNDER IRRADIATION BY NEUTRONS. H. D. Dietze and E. Balthesen (Technische Hochschule, Jülich, Ger.). J. Phys. Soc. Japan, 17: Suppl. B-I, 331-2(Mar. 1962).

In silicon iron with 3% silicon the magnetic relaxation was investigated at temperatures above 200°C under simultaneous irradiation by fast neutrons. The experiments can be explained by diffusion of vacancies into the domain walls. The results yield informations on the production and annihilation of vacancies during irradiation by fast neutrons. (auth)

37785 HYPERFINE STRUCTURE IN THE RARE EARTHS. B. Bleaney (Univ. of California, Berkeley). J. Phys. Soc. Japan, 17: Suppl. B-I, 435-9(Mar. 1962).

The size of the hyperfine structure constants of the

trivalent rare-earth ions in the fully magnetized state ($J_z = J$) is calculated from data on electron spin resonance in dilute salts. The results are compared with the available measurements on metals and garnets. Agreement is obtained for the metals within the experimental errors. (auth)

37786 SPIN-LATTICE RELAXATION IN DYSPROSIUM ETHYL SULPHATE. A. H. Cooke, C. B. P. Finn, B. W. Mangum, and R. L. Orbach (Oxford Univ.). J. Phys. Soc. Japan, 17: Suppl. B-I, 462-4(Mar. 1962).

Measurements of spin-lattice relaxation in dysprosium ethyl sulphate using magnetic fields along the symmetry axis of the crystal showed that at temperatures in the helium range the predominant relaxation mechanism is the resonance relaxation process, in which the relaxation time T_1 varies exponentially with 1/T. Application of crystalline field theory shows that in this substance the direct one-phonon process may be expected to be important at low temperatures, but that the relaxation time for this process will depend strongly on the angle between the magnetic field and the crystal axis, and should be least when the angle is $\pi/4$. This was confirmed experimentally. When the magnetic field is applied at $\pi/4$ to the axis the variation of the relaxation time with temperature and with field is quite changed, and at high fields it is possible to follow the transition from the resonance to the direct relaxation process, in which the relaxation time is inversely proportional to the temperature. (auth)

37787 ELECTRON SPIN ECHO STUDIES OF PARAMAGNETIC SYSTEMS. J. A. Cowen, D. E. Kaplan, and M. E. Browne (Lockheed Aircraft Corp., Palo Alto, Calif.). J. Phys. Soc. Japan, 17: Suppl. B-I, 465-8(Mar. 1962).

The temperature dependence of the spin lattice relaxation time T_1 in Ce^{3+}, Nd^{3+}, and Pr^{3+} diluted in lanthanum magnesium nitrate was measured by electron spin echo techniques at 9,300 Mc from 1.5 to 4.2°K. T_1 in Ce and Nd varies as exp (34/T) and exp (46/T) respectively, in good agreement with the Finn, Orbach, Wolf theory. In Pr, a non-Kramers system, T_1 varies as $T^{-6.5 \pm 0.5}$, presumably a Raman process. In all three cases, T_1 increases less rapidly at the low end of the temperature range where the transition to the direct process relaxation is taking place. The fast pulse apparatus has a resolving time of 5×10^{-9} sec and was used to measure T_1 and the phase memory time T_2 in a wide variety of dilute paramagnets. In Nd and Ce the echo formation can be visualized in analogy with the arguments that Hahn developed for nuclear spin echoes. In Pr where the r-f magnetic field is applied parallel to H_0 and to the c axis of the crystal, the formation of the echo is not clearly understood. (auth)

37788 FERROMAGNETISM IN GADOLINIUM TRICHLORIDE. W. P. Wolf, M. J. M. Leask, B. Mangum, and A. F. G. Wyatt (Oxford Univ.). J. Phys. Soc. Japan, 17: Suppl. B-I, 487-92(Mar. 1962).

Susceptibility and magnetization measurements were made on single crystals of $GdCl_3$ in the temperature range 1.5 to 20°K. The results indicate that this substance becomes ferromagnetically ordered at 2.2°K. Measurements were made on a number of differently shaped samples, both parallel and perpendicular to the crystallographic c-axis, in order to establish the direction of ferromagnetic alinement and to verify that the susceptibility in this direction is 1/N, (N is the demagnetizing factor), as expected for a spontaneously magnetic material in which the domains can move freely. To exclude the possibility that the ordering is ferri- rather than truly ferro-magnetic, magnetization measurements were made in fields large enough to remove the domains, but small compared with the internal ordering fields. The results extrapolated to T = 0°K show that the spontaneous moment is at least 80% of the predicted 7 μ_B/ion, the discrepancy being tentatively ascribed to zero-point disorder produced by the relatively large dipolar interactions. Magnetic dipole interactions also account satisfactorily for the observed anisotropy as deduced from magnetization measurements made with fields perpendicular to the easy axis. (auth)

37789 THE LOW TEMPERATURE HEAT CAPACITIES OF ANTIFERROMAGNETIC MnF_2 AND CoF_2. Edward Catalano and Norman E. Phillips (Univ. of California, Livermore and Berkeley). J. Phys. Soc. Japan, 17: Suppl. B-I, 527-9(Mar. 1962).

The heat capacities of MnF_2 and CoF_2 were measured in the temperature range 1–4.2°K. The data were analyzed by plotting CT^2 vs T^5 to separate the lattice and hyperfine contributions to the heat capacity from the magnetic contribution. The magnetic heat capacity for MnF_2 is compared with the heat capacity expected from spin waves modified by anisotropy. No apparent magnetic contribution to the heat capacity was found for CoF_2 in this temperature region. This is consistent with a high anisotropy field for this compound. (auth)

37790 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON MAGNETISM AND CRYSTALLOGRAPHY, KYOTO, SEPTEMBER 25-30, 1961. II. ELECTRON AND NEUTRON DIFFRACTION. J. Phys. Soc. Japan, 17: Suppl. B-II, 1-397(Mar. 1962).

The theoretical and experimental foundations of electron and neutron diffraction were presented. The topics discussed included gas electron diffraction, scattering phenomena in electron diffraction, diffraction effects in electron microscopic images, structure studies and applications and techniques of electron diffraction, general problems, techniques, and apparatus of neutron diffraction, and inelastic scattering and structure studies in neutron diffraction. Separate abstracts have been prepared for 23 of the 102 papers presented. Three papers were previously abstracted in NSA. (C.E.S.)

37791 CALCULATION OF THE INELASTIC SCATTERING FACTOR FOR THE 3p TO 4s TRANSITION IN ARGON AT 40 kv. Russell A. Bonham (Indiana Univ., Bloomington and Naval Research Lab., Washington, D. C.). J. Phys. Soc. Japan, 17: Suppl. B-II, 10-12(Mar. 1962).

The results of a calculation of the inelastic electron scattering factor for the excitation of low-lying bound states in atoms are presented. Calculations of the detailed shape of the angular intensity for scattered electrons exciting the $(3p^5,4s^1)$ state of argon were made and the details are presented. The calculation predicts that the scattering intensity is sensitive to the detailed structure of the radial atomic wave functions in both the ground and excited states. (auth)

37792 SIGNIFICANCE OF BOND LENGTHS DETERMINED BY ELECTRON DIFFRACTION. L. S. Bartell and Kozo Kuchitsu (Ames Lab., Ames, Iowa). J. Phys. Soc. Japan, 17: Suppl. B-II, 20-2(Mar. 1962).

The derivation of structural parameters of known absolute significance, as mean and equilibrium bond lengths, from experimental electron diffraction patterns is discussed. A series of diatomic molecules was investigated to test the theoretical interpretation of diffraction patterns, and, at the same time, to test the precision of the latest techniques of electron diffraction. Preliminary least

squares results for bond lengths and amplitudes of vibration for the molecules O_2, NO, N_2, and Cl_2, analyzed as Morse anharmonic oscillators, are reported. Standard errors range from 0.0008 to 0.003 Å. The results, when corrected for vibrational effects, are found to agree with spectroscopic results to within experimental error. A brief discussion is given of the possible utility of the accuracy now attainable in structure determinations. (auth)

37793 EXPERIMENTAL ASPECTS OF RELATIVISTIC EFFECT IN ELECTRON DIFFRACTION. Shizuo Miyake, Kunio Fujiwara, and Kunio Suzuki (Tokyo Univ.). J. Phys. Soc. Japan, 17: Suppl. B-II, 124-9(Mar. 1962).

On the basis of relativistic formula, the mean inner potential V_0 of MgO crystal was determined from the observations of refraction multiplets on (220) Debye rings, with electrons of energies ranging from 100 to 300 kv. The result is $V_0 = 13.4 \pm 0.3$. The magnitude of the additional term to the apparent mean inner potential due to inelastic scattering was also estimated. Change of the profile of symmetrical Kikuchi band with the electron energy by the relativistic effect was experimentally demonstrated. The necessity of relativistic correction, which is to be applied to Honjo-Kitamura's method of eliminating the primary extinction effect in observed intensities of reflections, was pointed out. Remarks on the relativistic effect on the contrast in electronmicroscopic images were given. (auth)

37794 CRYSTALLOGRAPHIC OUT-OF-STEP IN OXYGEN-DEFICIENT U_3O_8. Ryoitiro Sato (Mitsubishi Metal Mining and Metallurgical Lab., Omiya, Saitama, Japan) and Bumpei Ishii. J. Phys. Soc. Japan, 17: Suppl. B-II, 270-3(Mar. 1962).

The previous electron diffraction investigation of the reduction of U_3O_8 to U_3O_{8-x} showed that it is accomplished in a particular manner of crystallographic out-of-step. In connection with this, electron microscopic direct observations of arrangements of the out-of-steps in U_3O_{8-x} crystals are carried out. The results obtained are in accordance with the out-of-step structures deduced from the previous work. (auth)

37795 RECENT PROGRESS IN NEUTRON DIFFRACTION. G. E. Bacon (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phys. Soc. Japan, 17: Suppl. B-II, 324-9(Mar. 1962).

Some of the general advances in neutron diffraction techniques over the past five years are discussed, followed by an account of recent studies in neutron crystallography at Harwell on both magnetic and molecular structures. (auth)

37796 FERROMAGNETIC GROUPS. N. V. Belov and N. N. Neronova (Inst. of Crystallography, Moscow). J. Phys. Soc. Japan, 17: Suppl. B-II, 330-1(Mar. 1962).

Magnetic structures are described with the aid of Shubnikov groups. The number of ferromagnetic space groups is restricted to 275, which are subgroups of the highest symmetry for the axial vector, $\infty/m\ 2'/m'\ 2'/m'$. (C.E.S.)

37797 TABLES OF MAGNETIC SPACE GROUPS. II. SPECIAL POSITIONS. N. V. Belov, N. N. Neronova, J. D. H. Donnay, and Gabrielle Donnay (Inst. of Crystallography, Moscow; Johns Hopkins Univ., Baltimore; and Carnegie Institution, Washington, D. C.). J. Phys. Soc. Japan, 17: Suppl. B-II, 332-5(Mar. 1962).

The table of P4/mmm and related antigroups is presented as an example of the tables of special positions. (auth)

37798 COHERENT BRAGG SCATTERING OF RESONANT NUCLIDES. S. W. Peterson and H. G. Smith (Oak Ridge National Lab., Tenn.). J. Phys. Soc. Japan, 17: Suppl. B-II, 335-9(Mar. 1962).

Coherent Bragg scattering studies with neutrons on cadmium, boron, and lithium-containing compounds gave evidence of anomalous intensity behavior caused by the complex scattering amplitudes associated with neutron resonance. Bragg scattering intensities from (hkl) and ($\bar{h}\bar{k}\bar{l}$) mates in non-centrosymmetric crystals show a non-observance of Friedel's Law for all three elements, characteristic of crystals containing scatterers with complex amplitudes. In the case of cadmium, with its strong low energy resonance, pronounced resonance effects with strongly energy dependent scattering are observed. The Breit-Wigner resonance scattering expression accurately accounts for all of the observed effects. (auth)

37799 A TECHNIQUE FOR MEASURING THE MAGNETIC DISORDER SCATTERING OF NEUTRONS. R. D. Lowde and D. A. Wheeler (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phys. Soc. Japan, 17: Suppl. B-II, 342-6(Mar. 1962).

There is interest in measuring the contribution of magnetic origin to the background scattering of neutrons by magnetic alloys. A discussion is presented of the proper choice of experimental conditions for work with short-wavelength neutrons and of the corrections that must be applied to the data. Practical results are quoted, confirming the analysis and illustrating the procedure used in studies of Fe-Ni reported previously. (auth)

37800 NEUTRON DIFFRACTION WORK AT THE ISPRA CENTER. G. Caglioti, F. P. Ricci, A. Santoro, and V. Scatturin (CNEN, Ispra, Italy). J. Phys. Soc. Japan, 17: Suppl. B-II, 348-51(Mar. 1962).

Results recently obtained with the neutron diffraction spectrometer installed at the Ispra-1 reactor on the structure of liquid bromine and cupric oxide were presented. The neutron diffraction analysis of liquid bromine near the melting point was carried out up to a very large value of $4\pi \sin\theta/\lambda$. The radial distribution function shows clearly that in the liquid state, at room temperature, the molecules are not freely rotating. Moreover it seems that the main features of the structure of the parent solid are preserved during the melting process. The crystal and magnetic structures of copper oxide were confirmed. (auth)

37801 NEUTRON DIFFRACTION RESEARCH IN AUSTRALIA. T. M. Sabine (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Phys. Soc. Japan, 17: Suppl. B-II, 352-4 (Mar. 1962).

The single crystal spectrometer, powder spectrometer, and long-wavelength spectrometer used for neutron diffraction research are described. Neutron diffraction investigations of defect production in irradiated BeO and the long range ordering of oxygen in the Zr–Ti–O and Ti–O systems are discussed. (C.E.S.)

37802 NEUTRON DIFFRACTOMETER JAERI. N. Kunitomi, Y. Hamaguchi, M. Sakamoto, and S. Komura (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 17: Suppl. B-II, 354-8(Mar. 1962).

The multi-purpose neutron diffractometer of the Japan Atomic Energy Research Institute that can be used as a powder specimen type, single crystal specimen type, a polarized neutron diffractometer, and as a rotating crystal neutron spectrometer is described. The operation and control are fully automatic. Neutron diffraction patterns from aluminum and nickel are also illustrated. (C.E.S.)

37803 SINGLE-CRYSTAL NEUTRON DIFFRACTOMETER WITH AUTOMATIC PROGRAMMING-CONTROL SYS-

TEM. S. Miyake (Tokyo Univ.), S. Hoshino, K. Suzuki, H. Katsuragi, S. Hagiwara, T. Yoshie, and K. Miyashita. J. Phys. Soc. Japan, 17: Suppl. B-II, 358-62(Mar. 1962).

Outlines of two single-crystal neutron diffractometers utilizing one beam hole of a CP-5 type research reactor and programming-control systems adopted for these diffractometers are described. The procedure of operating the control system is illustrated by showing a result of the test of the diffractometers using a standard specimen. (auth)

37804 INTERATOMIC FORCES IN CRYSTALS FROM NEUTRON SCATTERING. B. N. Brockhouse (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Phys. Soc. Japan, 17: Suppl. B-II, 363-7(Mar. 1962).

The problem of determining the interatomic force constants in crystals from measurements of lattice vibrations by means of neutron inelastic scattering is discussed. For all except the simplest crystals it is necessary to determine the polarization vectors of the vibrations as well as their frequencies. In principle this can be done by measurement of the intensities as well as the energies of the one-phonon neutron groups. Such measurements seem to be feasible with the new constant-momentum-transfer method. A brief review is given of the Chalk River work on the crystal dynamics of metals, alkali halides, and semiconductors. (auth)

37805 LATTICE DYNAMICS OF THE AMMONIUM HALIDES. H. Palevsky (Brookhaven National Lab., Upton, N. Y.). J. Phys. Soc. Japan, 17: Suppl. B-II, 367-9(Mar. 1962).

The cold neutron scattering technique was applied to the study of the ammonium halides. The hindered rotation and optical vibrations are observed as single quantum transitions in contrast to the combination lines observed in optical measurements. In the high temperature phase (I) of NH_4I the motion of the ammonium ion may be described as a super position of a large amplitude hindered rotation and optical vibration. (auth)

37806 NEUTRON INELASTIC SCATTERING STUDY OF WATER. M. Sakamoto, B. N. Brockhouse, R. G. Johnson, and N. K. Pope (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Phys. Soc. Japan, 17: Suppl. B-II, 370-3(Mar. 1962).

A large number of measurements of the energy distributions of neutrons scattered by H_2O at 25 and 75°C were made under exceptionally high energy resolution (2×10^{-4} ev). From the results the scattering function $S(Q,\omega)$ was obtained for $0.4 \leq Q \leq 2$ Å^{-1} (75°C) and $0.4 \leq Q \leq 2.6$ Å^{-1} (25°C). No trace is seen of discrete energy transfers reported by other workers. The measurements were analyzed by means of the Van Hove transformation, and partial results of this analysis are reported. When the rms displacement of a proton exceeds the first neighbor distance the results seem to be describable by diffusion theory. (auth)

37807 COMMENTS ON RECENT WORK ON HYDROGEN ATOM LOCATION AND THERMAL MOTION DETERMINATION BY NEUTRON DIFFRACTION. Walter C. Hamilton (Brookhaven National Lab., Upton, N. Y.). J. Phys. Soc. Japan, 17: Suppl. B-II, 374-5(Mar. 1962). (BNL-5671)

The accuracy of the results of neutron diffraction investigations of the C–H and O–H bond length and amplitudes of intramolecular thermal vibrations is discussed. Suggestions for improved accuracy are also presented. (C.E.S.)

37808 A NEUTRON DIFFRACTION STUDY OF POLYCRYSTALLINE $HCrO_2$ AND $DCrO_2$. Walter C. Hamilton (Brookhaven National Lab., Upton, N. Y.) and James A. Ibers. J. Phys. Soc. Japan, 17: Suppl. B-II, 383-4(Mar. 1962). (BNL-5566)

On the basis of powder neutron diffraction data the O–O bond in $DCrO_2$ is shown to be asymmetric. Results for the O–H–O bond in $HCrO_2$ are less certain, but tend to support a symmetric hydrogen bond. (auth)

37809 NEUTRON DIFFRACTION STUDY OF THE CRYSTAL STRUCTURE OF SOLID HYDROGEN AND DEUTERIUM. R. P. Ozerov, V. S. Cogan, G. S. Zhdanov, and G. B. Lazarev (Karpov Inst. of Physical Chemistry, Moscow and Inst. of Technical Physics, Krakow). J. Phys. Soc. Japan, 17: Suppl. B-II, 385-6(Mar. 1962).

A neutron diffraction analysis at 12°K confirms the structure of deuterium determined by x-ray method and the tetragonal version of the structure of hydrogen. It was found that the neutron diffraction pattern for hydrogen as well as deuterium shows much more diffraction peaks than those in x-ray pattern. This is due to the appearance of the reflections at angles that are larger than those at which the intensity of x-ray diffraction vanishes and to the appearance of the reflections with odd sum of indices that are forbidden for body-centered structures consisting of identical particles. The latter fact can be understood if one assumes that ortho- and paramolecules are arranged in an orderly manner in the lattice and possess different coherent scattering amplitudes for neutrons. The forms and sizes of unit cells and the intermolecular distances are given. (auth)

37810 DETERMINATION OF HYDROGEN POSITION IN MANGANITE, MnOOH, WITH NEUTRON DIFFRACTION. H. Dachs (Universität, Munich). J. Phys. Soc. Japan, 17: Suppl. B-II, 387-9(Mar. 1962). (In German)

Manganite is monoclinic, pseudorhombic. Its structure is a superstructure based upon the marcasite type. The crystals show polysynthetic twinning. By x-ray measurements on a thin untwinned cleavage sample, improved Mn parameters were obtained. For the neutron investigations twinned crystals were used. Because of the polysynthetic twinning normally non identical reflections were superimposed, excepting (hk0), (0kl) and certain (h0l) reflections. From these reflections the H- position was derived. The neutron diffraction measurement proved that the hydrogen is bonded to certain oxygen ions. High temperature measurements showed that the superstructure exists up to the decomposition temperature of manganite. (auth)

37811 X-RAY AND NEUTRON STUDY ON THE PHASE TRANSFORMATION OF $NaNO_2$. Mortimer I. Kay (Lewis Research Center, Cleveland), B. Chalmers Frazer, and Ryuzo Ueda. J. Phys. Soc. Japan, 17: Suppl. B-II, 389-91 (Mar. 1962).

The crystal structure of sodium nitrite was studied by neutron diffraction. The lattice parameters and temperature factors at room temperature were already reported by Kay and Frazer. The agreement between observed and calculated intensities was quite good. The high temperature phase of the compound was studied at 185°C by x-ray and neutron diffraction. Refinements were carried out using models of NO_2 group as a free rotator, hindered rotator, and as a disordered structure. The final results obtained as an hindered rotator gave an R of 0.085. The distinction between positional disorder and hindered rotation is not very meaningful at 185°C. It seems sensible to regard the structure at 185°C as positionally disordered. (auth)

37812 VACANCY DISTRIBUTION IN γ-Fe_2O_3. Ryuzo Ueda and Kinichi Hasegawa (Waseda Univ., Tokyo). J. Phys. Soc. Japan, 17: Suppl. B-II, 391-4(Mar. 1962).

The vacancy distribution in γ-Fe_2O_3 is determined by the x-ray and neutron diffraction. The vacancies do not distribute uniformly through cation sites, but occupy the particular positions of the lattice on the average. A number of extra lines in the diffraction patterns of both the x-ray and neutron, which do not appear in the magnetite structure, were observed. The intensity calculations were performed by estimating various kinds of vacancy contributions to the diffraction intensities. The existence of the extra lines ruled out the Verwey model in which vacancies distribute in disorder. Among the several models in which vacancies occupy the special positions statistically in cation sites, the most probable one was selected. The agreement between calculated and observed intensities was quite good. (auth)

37813 NEUTRON DIFFRACTION STUDIES OF HIGHER CARBIDES OF HEAVY METALS. Masao Atoji (Argonne National Lab., Ill.). J. Phys. Soc. Japan, 17: Suppl. B-II, 395-7(Mar. 1962).

The neutron diffraction and paramagnetic scattering analyses of the CaC_2 type carbides (CaC_2, YC_2, LaC_2, CeC_2, TbC_2, YbC_2, LuC_2, UC_2) and the Pu_2C_3 type carbides (La_2C_3, Ce_2C_3, Pr_2C_3, Tb_2C_3) show strong correlations between the interatomic distances and the metal valency. These correlations and the vanishing Knight shift of YC_2 can reasonably be interpreted from the following postulations. The conduction band wave functions of MC_2 are composed only of the metal d-orbitals and the $C_2-\pi_g2p$ antibonding orbitals. The $C_2-\pi_g2p$ contribution to the conduction band is smaller in M_2C_3 than in MC_2. The conduction band of M_2C_3 is also associated with the metal s-orbital. (auth)

37814 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON MAGNETISM AND CRYSTALLOGRAPHY, KYOTO, SEPTEMBER 25-30, 1961. III. NEUTRON DIFFRACTION STUDY OF MAGNETIC MATERIALS. J. Phys. Soc. Japan, 17: Suppl. B-III, 1-71(Mar. 1962).

Separate abstracts were prepared for eighteen papers on investigations of crystal structure, magnetic properties and structure, critical scattering, ordering, spin waves, and other topics. The other two papers included were previously abstracted in NSA. (D.C.W.)

37815 MAGNETIC ELECTRON CONFIGURATION IN IRON. C. G. Shull and Y. Yamada (Massachusetts Inst. of Tech., Cambridge). J. Phys. Soc. Japan, 17: Suppl. B-III, 1-6(Mar. 1962).

An accurate determination of the magnetic scattering amplitude for iron was performed using polarized neutron radiation. The three dimensional Fourier analysis shows a nonspherical 3d spin density distribution with favoritism towards the E_g symmetry configuration. A comparison of the data with a calculated magnetic form factor including 3d orbital and other shell contributions suggests that the 4s electron carries a net magnetic moment 0.21 μ_B coupled antiparallel to 3d magnetic moment 2.39 μ_B. (auth)

37816 THE MAGNETIC FORM FACTOR OF NICKEL OXIDE. Harvey A. Alperin (Naval Ordnance Lab., Silver Spring, Md. and Brookhaven National Lab., Upton, N. Y.). J. Phys. Soc. Japan, 17: Suppl. B-III, 12-15(Mar. 1962). (BNL-5612)

Measurement of the magnetic form factor of a single crystal of nickel oxide to large values of $\sin\theta/\lambda$ reveals appreciable anisotropies in the unpaired electron distribution which are due to the effect of the crystalline electric field. Accurate temperature factors, B(oxygen) = 0.37 and B(nickel) = 0.26, were determined from powder data. Corrections to the inner magnetic reflections were made for secondary extinction and double Bragg scattering was removed from the outer reflections by measurement at two wavelengths. A direct Fourier projection of the data showed that the unpaired spin density has e_g-type symmetry. The form factor was put on an absolute basis by a method which requires no knowledge of either the absolute intensities or the moment on the Ni^{++} ion. The spherical and aspherical parts of the form factor were deduced directly from the data. The single crystal measurements, which agree with those obtained from a powder sample, yield an electron distribution more compact than is indicated by the latest free atom calculations. (auth)

37817 ATOMIC MAGNETIC MOMENT IN B2 TRANSITION ALLOYS. I. ALLOY VFe. R. J. Chandross and D. P. Shoemaker (Massachusetts Inst. of Tech., Cambridge). J. Phys. Soc. Japan, 17: Suppl. B-III, 16-19(Mar. 1962).

The atomic moments in 77% ordered 47 atomic % Fe–V alloy were determined approximately by neutron diffraction. The spins of the Fe and V sites were found to be respectively 0.305 ± .040 and 0.070 ± .040 based on the Freeman and Watson neutral-atom spherical 3d form factors. These correspond to about 0.36 for each Fe atom, and 0.035 for each V, in a completely ordered 1:1 alloy. Indications were obtained from x-ray measurements that there is some electron transfer from Fe to V; taking this into account would result in slightly smaller values of the Fe spin. A powder spectrum of Fe–Ti at room temperature showed no magnetic effects. (auth)

37818 ON THE MAGNETIC MOMENTS AND THE DEGREE OF ORDER IN IRON–NICKEL ALLOYS. M. F. Collins, R. V. Jones, and R. D. Lowde (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phys. Soc. Japan, 17: Suppl. B-III, 19-26(Mar. 1962).

The background scattering of neutrons by iron-nickel alloys indicates short-range order in supposedly disordered specimens as far removed from the stoichiometric ratio for Ni_3Fe as 60Fe–40Ni, despite anneals at temperatures as high as 650 and 1000°C. A comparison of the nuclear and magnetic scattering distributions shows that the magnetic moments display a degree of ordering closely similar to that of the chemical constituents, and this demonstrates that within the accuracy of the measurements there must exist two magnetic moments in the crystal, one characteristic of an iron site and one of a nickel site. The values of these moments are determined at four alloy compositions, and are consistent with the earlier results of Shull and Wilkinson. (auth)

37819 RECENT MAGNETIC NEUTRON SCATTERING INVESTIGATIONS AT OAK RIDGE NATIONAL LABORATORY. M. K. Wilkinson, H. R. Child, W. C. Koehler, J. W. Cable, and E. O. Wollan (Oak Ridge National Lab., Tenn.). J. Phys. Soc. Japan, 17: Suppl. B-III, 27-31(Mar. 1962).

A brief summary is given of recent neutron diffraction investigations at the Oak Ridge National Laboratory on rare-earth metals and intermetallic compounds. (auth)

37820 RECENT PROGRESS IN MAGNETIC STRUCTURE DETERMINATIONS OF RARE EARTH METALS. W. C. Koehler, J. W. Cable, E. O. Wollan, and M. K. Wilkinson (Oak Ridge National Lab., Tenn.). J. Phys. Soc. Japan, 17: Suppl. B-III, 32-5(Mar. 1962).

Recent work on single crystal specimens of rare earth

metals that was carried out at the Oak Ridge National Laboratory during the last two years is summarized. Results are presented for thulium and for terbium. Experiments designed to investigate the magnetization process in holmium are described. (auth)

37821 NEUTRON DIFFRACTION STUDY OF CHROMIUM SINGLE CRYSTALS. G. Shirane and W. J. Takei (Westinghouse Research Labs., Pittsburgh). J. Phys. Soc. Japan, 17: Suppl. B-III, 35-8(Mar. 1962).

The temperature dependence of magnetic intensities and spacings of (100) satellites of a Cr single crystal was investigated through the Néel temperature at 310°K and the low temperature transition at 121°K. No higher order satellites, characteristic of the antiphase structure, were observed in either phase. If the reasonable assumption is made that the atomic moment does not change appreciably through the low temperature transition, the available data imply a sinusoidal modulation of the magnetic scattering amplitude with the spin direction parallel to the propagation vector below the 121°K transition and perpendicular to it above. This model gives the true moment of Cr as 0.59 μ_B at 78°K. (auth)

37822 MAGNETIC MOMENT DISTRIBUTION IN PALLADIUM AND IRON GROUP ALLOYS. E. O. Wollan, J. W. Cable, W. C. Koehler, and M. K. Wilkinson (Oak Ridge National Lab., Tenn.). J. Phys. Soc. Japan, 17: Suppl. B-III, 38-40(Mar. 1962).

The distribution of the magnetic electrons in the orbital of the individual atoms in alloys of palladium and nickel with iron and cobalt is discussed. Magnetic moment data suggest that a change in orbital splitting gives rise to ferromagnetism in dilute iron group-palladium alloys. (auth)

37823 THE MAGNETIC STRUCTURE OF $MnCr_2O_4$. J. M. Hastings and L. M. Corliss (Brookhaven National Lab., Upton, N. Y.). J. Phys. Soc. Japan, 17: Suppl. B-III, 43-5(Mar. 1962). (BNL-5611)

Neutron diffraction patterns were obtained from $MnCr_2O_4$ at 300, 77, 20, and 4.2°K. $MnCr_2O_4$ is a regular spinel with an oxygen parameter equal to 0.389. The Néel temperature was found to be 43°K in good agreement with magnetic measurements. At 18°K a further ordering sets in which results in a large number of superlattice lines that cannot be indexed on the basis of the spinel unit cell. The model of Kaplan which postulates a ferrimagnetic spiral is shown to be in semi-quantitative agreement with the observed low temperature pattern. (auth)

37824 MAGNETIC PROPERTIES AND STRUCTURES OF URANIUM-3d TRANSITION ELEMENT ALLOYS. Y. Hamaguchi, S. Komura, N. Kunitomi, and M. Sakamoto (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 17: Suppl. B-III, 46-8(Mar. 1962).

From measurements of the magnetic susceptibility, the Mössbauer effect, the electrical resistivity and the magnetic scattering of thermal neutrons, it is concluded qualitatively that UFe_2 is simply ferromagnetic and that its magnetic moment is mainly due to the magnetic moment of Fe atoms. (auth)

37825 NEUTRON DIFFRACTION INVESTIGATION OF ORDER-DISORDER IN THE ALLOYS "FERRUM–NICKEL" AND "FERRUM–COBALT." B. G. Lyashenko (Central Research Inst. for Ferrous Metallurgy, Moscow), D. F. Litvin, I. M. Puzey, and J. G. Abov. J. Phys. Soc. Japan, 17: Suppl. B-III, 49-52(Mar. 1962).

Large single crystals of Fe–Ni alloys belonging to the permalloy class and including binary alloys of Fe and Ni and ternary alloys of Fe and Ni with Mo, Cr and Cu were studied. New results were obtained for the equilibrium phase of alloys on the basis of thermodynamics of order-disorder transformation. The dependence of magnetic anisotropy constant on the degree of long range order in Ni_3Fe alloy is given. The atomic order-disorder phenomena in Fe–Co alloys that have body-centered-cubic crystal lattices were investigated using a polycrystal sample. The existence of the equiatomic superlattice over a wide range in Fe–Co system was discovered: approximately from 25% Co to the boundary of $\alpha \rightleftharpoons \gamma$ transformation (~75% Co). It is concluded that the energy of order-disorder transformation of Fe–Ni and Fe–Co alloys is in general due to 3d-exchanged interaction. (auth)

37826 STUDY OF SOME MAGNETIC STRUCTURES AT THE CENTER OF NUCLEAR STUDY AT GRENOBLE. E. F. Bertaut (CEN, Grenoble, France), A. Delapalme, F. Forrat, G. Roult, F. de Bergevin, and R. Pauthenet. J. Phys. Soc. Japan, 17: Suppl. B-III, 53-4(Mar. 1962). (In French)

The transition temperature of Fe–Rh from the antiferromagnetic state to the ferromagnetic state was found to increase as the Rh % increased. The Fe–Rh crystal structure was determined to be of the CsCl type, while its magnetic structure is of the G type. Cr_2Se_4 was found to be antiferromagnetic with a crystal structure like deformed As–Ni and a magnetic structure very similar to $MnBr_2$. $UMnO_4$ and $UCoO_4$, isomorphs of $UMgO_4$, have Neel temperatures of 12°K; data indicate a magnetic moment of $4\mu_b$ for Co^{2+}. The $UCoO_4$ magnetic structure is shown. (D.C.W.)

37827 A NEUTRON-DIFFRACTION STUDY OF MANGANESE FERRITES. I. I. Yamzin, N. V. Belov, and Yu. Z. Nozik (Inst. of Crystallography, Moscow). J. Phys. Soc. Japan, 17: Suppl. B-III, 55-7(Mar. 1962).

The neutron diffraction intensities of $Mn_xFe_{3-x}O_4$ ($0.43 \leq X \leq 1.51$) were measured at room temperature and above the Curie point using single crystals prepared by Verneuil's method. The dependence of the degree of inversion and the oxygen parameter on the chemical composition was investigated. (D.C.W.)

37828 ANTIFERROMAGNETISM OF $NiCO_3$. R. A. Alikhanov (Inst. for Physical Problems, Moscow). J. Phys. Soc. Japan, 17: Suppl. B-III, 58-60(Mar. 1962).

Neutron diffraction investigations confirmed the existence of antiferromagnetism in $NiCO_3$ as observed previously. The observation shows a Néel temperature about 25°K. Reflections (111) and (100) appear simultaneously in diffraction patterns obtained at low temperatures. In accord with the theory of Dzyaloshinsky, this indicates the presence of weak ferromagnetism in these dielectrics. (auth)

37829 SOME EXPERIMENTS ON MAGNETIC INELASTIC SCATTERING OF NEUTRONS. Tormod Riste (Institutt for Atomenergi, Kjeller Research Establishment, Lillestrøm, Norway). J. Phys. Soc. Japan, 17: Suppl. B-III, 60-2(Mar. 1962).

Two methods for studying the thermal excitations that give rise to inelastic scattering are described and shown to give consistent results. The temperature behavior of spin waves in magnetite is investigated. When approaching the Curie temperature, the lifetime and the energy of the spin waves are found to decrease. The temperature region in which the decrease shows up depends on the wavelength of the spin waves. (auth)

37830 CRYSTAL FIELD SPECTRA IN RARE EARTH OXIDES. B. N. Brockhouse, L. N. Becka, K. R. Rao, R. N. Sinclair, and A. D. B. Woods (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Phys. Soc. Japan, 17: Suppl. B-III, 63-6(Mar. 1962).

Lines with energies up to 60 mev and widths on the order of milli-ev were observed in the energy distribution of neutrons scattered by Ho_2O_3, Er_2O_3, and Tb_2O_3, corresponding to transitions within the ground state multiplet of the rare earth ion split by the crystal field. The lines were studied at different temperatures under different scattering conditions. (auth)

37831 CRITICAL SCATTERING OF NEUTRONS BY NICKEL. D. Cribier, B. Jacrot, and G. Parette (CEN, Saclay, France). J. Phys. Soc. Japan, 17: Suppl. B-III, 67-8(Mar. 1962).

Critical scattering of neutrons by nickel was studied by the time-of-flight technique. Complete measurements were made at and above the transition temperature T_C. The two more important results are: the existence of a rather important inelasticity at T_C and a term in K^4 in the spatial dependence of the cross section. This last point is an important difference with the case of iron. (auth)

37832 AN INVESTIGATION OF MAGNONS IN FRANKLINITE BY THE NEUTRON SCATTERING METHOD. A. Murasik, K. Ruta-Wala, and A. Wanic (Inst. for Nuclear Physics, Krakow). J. Phys. Soc. Japan, 17: Suppl. B-III, 69-71(Mar. 1962).

Diffuse scattering around the (111) Bragg reflection was studied at liquid air temperature, using a monochromatic neutron beam. The observed broad diffuse scattering peaks were proved to be primarily of magnetic origin. Comparison of experimental and calculated shapes for the peaks indicates a quadratic dispersion relation for the magnons. (D.C.W.)

37833 NUCLEAR QUADRUPOLE RESONANCE UNDER HIGH PRESSURE. [PART] II. Tokujiro Fuke (Tokushima Univ., Japan). J. Phys. Soc. Japan, 18: 1154-61(Aug. 1963).

The study of temperature and volume dependence of nuclear quadrupole resonance frequency is extended to crystals with large asymmetry parameter η. The resonance frequency of the I^{127} nucleus in mercuric iodide (red) was measured as a function of hydrostatic pressure in the range 1 to 8000 kg/cm^2 at three temperatures. It is found that η depends more strongly on volume than e^2Qq_{zz}/h does, whereas η and e^2Qq_{zz}/h depend on lattice vibration amplitudes similarly. From the volume dependence of η the heterogeneity of the atomic displacements in the unit cell is estimated. Furthermore, by using both temperature and volume dependence data of q_{zz} and η, the origin for the variation of the resonance frequency is discussed. (auth)

37834 COLOR CENTERS IN $NaClO_3$ CRYSTALS. S. B. S. Sastry and C. Ramasastry (Indian Inst. of Tech., Madras). J. Phys. Soc. Japan, 18: 1220-21(Aug. 1963).

It is found that $NaClO_3$ crystals produced a yellow color when exposed to x radiation. It was found that these color centers are not produced by additive coloration or by exposure to any region of the ultraviolet between 2200 and 4000 Å. Single crystals of sodium chlorate were used. (R.E.U.)

37835 HIGH FIELD MAGNETIZATION OF GADOLINIUM METAL. D. S. Rodbell (General Electric Research Lab., Schenectady, N. Y.). J. Phys. Soc. Japan, 18: 1232-3(Aug. 1963).

The high magnetic field behavior of gadolinium metal and the comparison between that behavior and the predictions of the molecular field model are reported. Measurements were made on a c-axis oriented single crystal of gadolinium in pulsed fields to 140 k-oersted and over a range of temperatures. (R.E.U.)

37836 SUPERCONDUCTORS AT WORK. E. R. Schrader (Radio Corp. of America, Princeton, N. J.). New Scientist, 19: 486-8(Sept. 5, 1963).

The uses of superconductors are discussed, with special emphasis on electromagnets, including the protection of spacemen against radiation. The three areas of application for superconductors are roughly categorized as follows: devices that use the superconducting properties to detect, manipulate, or control relatively small signals; devices that use the ability of the superconductor to exclude magnetic fields from its bulk; and devices that use the zero-resistance property of the superconductor to eliminate power losses in the transmission of electric currents. (M.C.G.)

37837 HYDRODYNAMIC EFFECTS PRODUCED BY PULSE MICROWAVE DISCHARGES. Shao-Chi Lin and George P. Theofilos (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 6: 1369-79(Oct. 1963).

An elementary theory is proposed for estimating the strength of pressure waves to be expected from sudden breakdown of a gas by high-frequency electromagnetic waves in a one-dimensional geometry. It is shown that, for an uncontrolled breakdown where the local field strength is not carefully matched to the instantaneous plasma condition to avoid strong reflections, the heating effect will be self limiting and the resultant shock strength depends only on the incident wave frequency and on the initial gas density. Numerical example for microwave breakdown in air indicates that, at normal sea level density, the shock wave accompanying the breakdown is generally quite weak (of the order of Mach 1.1 at 100 Bc frequency). However, for breakdown at lower air densities, stronger shock waves can be anticipated. Preliminary experimental observations of pressure waves generated in a one-dimensional channel by pulse microwave discharges tended to confirm the general features of the elementary theory but showed somewhat stronger effects than predicted. (auth)

37838 SOME EXACT SOLUTIONS OF MAGNETOHYDRODYNAMICS. Mahinder S. Uberoi (Univ. of Colorado, Boulder). Phys. Fluids, 6: 1379-81(Oct. 1963).

Four examples of the exact solutions of two-dimensional magnetohydrodynamics of incompressible inviscid fluid are given. Two are valid for infinite conductivity and the other two for finite conductivity. (auth)

37839 PRECURSOR WAVES IN SHOCK TUBES. A. C. Pipkin (Brown Univ., Providence). Phys. Fluids, 6: 1382-8 (Oct. 1963).

Weymann's observation of a wave of electrons propagating from a strong shock into the region ahead of it is considered. By taking into account the mutual electrostatic repulsion of the electrons through a simple approximation, the main features of the precursor wave motion can be explained. In particular, the theory predicts the relatively gradual decrease in electron density from the shock to the electrostatic front, followed by exponential decay upstream from the electrostatic front. (auth)

37840 GAS-IONIZING SHOCK WAVES WITH OBLIQUE FIELDS. J. B. Helliwell (Royal Coll. of Science and Tech., Glasgow). Phys. Fluids, 6: 1516-17(Oct. 1963).

Basic equations are given for a gas-ionizing shock wave in a nonviscous, nonheat-conducting gas. The energy of ionization and radiation effects are neglected. Previous re-

sults due to Zhilin are summarized, and extensions are made, first, when the shocks are noncompressive, and, second, when the upstream velocity and magnetic fields are coplanar. Although existence of these shocks has not been proven, there exists a need for rigorous study of the gas-ionizing shock structure with oblique fields. (R.E.U.)

37841 NOTE ON MAGNETIC LOOPS. Y. Mimura and B. P. Leonard (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 6: 1521-2(Oct. 1963).

A simply connected region of space, free from externally applied electric fields, containing a fluid of scalar conductivity and finitely conducting bodies of arbitrary configuration is considered. It is proven that, for the steady flow of this fluid, there can be no magnetic-field loops in the space. An extension to the infinite-fluid-conductivity approximation can be made, if one assumes that current density is finite everywhere. (auth)

37842 ENTRY PROBLEM IN ELECTROHYDRODYNAMICS. J. L. Shohet (Johns Hopkins Univ., Baltimore). Phys. Fluids, 6: 1524-5(Oct. 1963).

Laminar electrohydrodynamic flow is considered in the entrance region of two-channel configurations, plane and annular. The method utilized to solve for the velocity profiles is that of a numerical finite difference scheme that considers the nonlinearities present in the momentum equation without linearizing approximations. (R.E.U.)

37843 EFFECT OF A CONDENSED PHASE ON THE ELECTRON DENSITY IN A GAS. J. J. Allport and E. B. Rigby (United Tech. Center, Div. of United Aircraft Corp., Sunnyvale, Calif.). Phys. Fluids, 6: 1525-6(Oct. 1963).

The presence of a gas phase in contact with the surface of particles in a high-temperature gas-particle system is considered using the Richardson equation to predict the electron density. (R.E.U.)

37844 GROUND-STATE ENERGY AND SOUND VELOCITY OF A SYSTEM OF INTERACTING BOSONS. V. J. Emery (Univ. of Birmingham, Eng.), J. L. Gammel, and F. R. A. Hopgood. Phys. Rev., 132: 10-14(Oct. 1, 1963). (LADC-5813)

The method of Padé approximants is used to evaluate the ground-state energy E_0 of a system of interacting bosons. The density ρ_0 of particles in the zero-momentum state appears as a free parameter. In particular, the method is applied to a system of hard spheres of radius c and density ρ. The result is close to the exact value for low densities and has a singularity at a density which corresponds to close packing when $\rho_0 = {}^1\!/_4\rho$. The calculated sound velocity as a function of ρ coincides with the experimental values for liquid helium II for $\rho_0 = {}^1\!/_4\rho$ and c = 2.16 Å. (auth)

37845 FLUXOID QUANTIZATION, PAIR SYMMETRY, AND THE GAP ENERGY IN THE CURRENT-CARRYING BARDEEN-COOPER-SCHRIEFFER STATE. Murray Peshkin (Argonne National Lab., Ill.). Phys. Rev., 132: 14-20 (Oct. 1, 1963).

The method of Byers and Yang is extended for application to the current-carrying BCS state by including the magnetic interaction between electrons in the zero-order Hamiltonian. In the case of a thin superconducting ring, the problem is reduced to the zero-current problem by separating out the collective motion. In the general case, this process is not carried out completely, but the symmetry of the BCS state provides enough information to obtain the desired results. When the fluxoid is equal to an integral multiple of $(\pi\hbar c/e)$, the single-particle states occur in pairs which go into each other under reflection about the average electron velocity at each point. A qualitative argument is given to show why this symmetry is necessary for the BCS reduced interaction to have its full effectiveness. The crux of the matter is that in the absence of such symmetry, the Fermi surface is irregular and a substantial fraction of the important states near that surface are unable to participate in a coherent BCS wave function. The Meissner effect is not necessary for the quantization of magnetic flux. (auth)

37846 RELAXATION OF LONGITUDINAL AND TRANSVERSE COMPONENTS OF NUCLEAR MAGNETIZATION IN LIQUIDS. Peter M. Richards (Università, Pavia, Italy). Phys. Rev., 132: 27-32(Oct. 1, 1963).

In the limit of molecular rotation sufficiently rapid to give a white spectrum to the dipole interaction, it is shown that the longitudinal and transverse components of nuclear magnetization relax in an identical manner for a system of an arbitrary number of identical nuclei with arbitrary spin, provided Boltzmann-like initial conditions are assumed. This gives generalization to the specific result obtained by Hubbard for four equivalently located spin ½ nuclei as well as to the familiar $T_1 = T_2$ for two identical spins. The Hamiltonian studied consists of Zeeman and dipole-dipole terms. If chemical shifts or scalar spin-spin interactions are included, the results remain valid for equivalent spins but cannot be applied to nonequivalent spins. As an example, Hubbard's three-spin calculation is repeated to include the transverse component, and it is illustrated that if other than Boltzmann-like initial conditions are used, the components need not relax identically. (auth)

37847 ELECTRON TRANSPORT PHENOMENA IN BISMUTH AT LIQUID-HELIUM TEMPERATURES. C. G. Grenier, J. M. Reynolds, and J. R. Sybert (Louisiana State Univ., Baton Rouge). Phys. Rev., 132: 58-73(Oct. 1, 1963).

Transport effects were studied in a bismuth single crystal at liquid-helium temperatures in a magnetic field. Except for a field orientation study of the galvanomagnetic effects for mapping the light-holes ellipsoid, all the measurements were taken in the basal plane of the crystal with the field parallel to the trigonal axis. The thermal conductivity was found to be almost entirely due to lattice conductivity; therefore, the experimental coefficients determined were limited to the following: the isothermal transverse magnetoresistivity ρ_{11}, the isothermal Hall resistivity ρ_{21}, the (adiabatic) thermoelectric coefficient ϵ_{11}', the (adiabatic) Nernst-Ettinghausen coefficient ϵ_{21}', and the transverse magnetothermal resistivity γ_{11}. The Peltier tensor coefficients were expected from the Onsager relations to be too small to be measurable and thus, were not studied here. All these effects, except the thermal resistivity coefficient exhibit the Schubnikov-de Haas type oscillations. The kinetic coefficients of the transport effects σ_{11}, σ_{12}, ϵ_{11}'', and ϵ_{12}'' were computed from the experimental coefficients and compared with available theories. A rough analysis of the gross effects was made by a decomposition of each coefficient into a sum of different band contributions, each band being approximated by a Lorentz term. General, but not complete, agreement between experiment and theory is achieved for both two-band and multiband models. No special mechanism (i.e., like that proposed for zinc) is needed to explain the oscillations in the different effects, since the Lifshitz and Kosevich theory (σ_{12}), the Zil'berman theory (σ_{11},ϵ_{11}''), and the influence of oscillation in the density of states (ϵ_{12}'') lead to satisfactory agreement with the experiments. (auth)

37848 EFFECT OF DISSOLVED GASES ON SOME SUPERCONDUCTING PROPERTIES OF NIOBIUM. Warren DeSorbo (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 132: 107-21(Oct. 1, 1963).

The addition of interstitial solute atoms to niobium, in concentrations below the solubility limit, lowers the transition temperature. Interstitial oxygen has the largest effect, decreasing T_c by 0.93°K per at. %; while increasing the resistivity in the normal state by 5.2 μΩ cm per at. %. Magnetization curves obtained on niobium ($R_{298°K}/R_{10°K} \approx 500$) and on similar specimens containing interstitial oxygen or nitrogen are substantially reversible and are similar to the shape predicted by Abrikosov for superconductors of the second kind. The field first penetrating the sample, H_{FP}, less than the thermodynamic critical field, H_c, decreases with increasing concentration of the interstitial atom, while H_N, the field at which the normal state is restored (as determined from magnetization measurements), increases. The ratio, H_N/H_c, is a linear function of ρ_n. When the solubility limit is exceeded, hysteresis effects become more pronounced similar to those predicted by Bean's model. Resistive measurements at low current density in longitudinal magnetic fields indicate that both niobium and its interstitial solid solutions exhibit some superconducting properties above H_N. (auth)

37849 EFFECT OF TEMPERATURE AND PRESSURE ON THE RESISTANCE OF FOUR ALKALI METALS. R. A. Stager and H. G. Drickamer (Univ. of Illinois, Urbana). Phys. Rev., 132: 124-7(Oct. 1, 1963).

The electrical resistance of lithium, sodium, potassium, and rubidium was measured as a function of pressure to over 500 kbar at 77°K and 296°K. Lithium exhibits an initial rise in resistance, a first-order phase transition at 70 kbar with a large resistance crop, and a very gradual rise in resistance at high pressure. Sodium has a rise in resistance with pressure at both 77 and 296°K. The high-temperature isotherm exhibits a very broad maximum at high pressure. For potassium, the 296°K isotherm shows a rise by a factor of 50 in 600 kbar. The 77°K isotherm shows a sluggish transition at 280 kbar and a very sharp transition at 360 kbar. The latter is almost certainly martensitic. Both isotherms for rubidium have qualitatively similar behavior: a rise in resistance which accelerates with increasing pressure, a discontinuous rise at 190 kbar (210 kbar at 77°K), and a broad maximum at high pressure. The discontinuous rise is probably due to a electronic transition. (auth)

37850 MAGNETOSTRICTION IN DYSPROSIUM AND TERBIUM. F. J. Darnell (E. I. du Pont de Nemours and Co., Wilmington, Del.). Phys. Rev., 132: 128-33(Oct. 1, 1963).

The general expressions for single-crystal magnetostriction correct to second order (sixth-rank magnetostrictive tensor) are reduced and evaluated for the particular anisotropies of Dy and Tb. The mangetostrictive constants are determined from x-ray-diffraction measurements of the crystal cell distortions. Expressions for the polycrystalline magnetostriction are obtained by suitable averaging and compared with values from the literature. (auth)

37851 CORRELATION BETWEEN IRRADIATION AND THERMALLY INDUCED DEFECTS IN II–VI COMPOUNDS. M. R. Lorenz, M. Aven, and H. H. Woodbury (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 132: 143-4(Oct. 1, 1963).

Recently, a unique new double-acceptor defect produced in CdS and CdTe by heat-treating single crystals at 800 to 1000°C in Cd was reported. An analogous defect was observed in ZnSe fired in liquid Zn. The production of this defect in CdTe, CdS, and ZnSe by electron irradiation is reported. (auth)

37852 MAGNETIC PROPERTIES OF THE HEXAGONAL ANTIFERROMAGNET $CsMnF_3$. Kenneth Lee, A. M. Portis, and G. L. Witt (Univ. of California, Berkeley). Phys. Rev., 132: 144-63(Oct. 1, 1963).

The magnetic properties of the hexagonal antiferromagnet $CsMnF_3$ were investigated by magnetic susceptibility, torsion, electron resonance, and nuclear-antiferromagnetic double resonance. Torsion measurements establish a transition to an antiferromagnetically ordered state at 53.5°K. A weak sixfold anisotropy in the transverse plane and a large axial anisotropy along the c axis corresponding, respectively, to the fields $36K_3/M = 1.1$ and $K_1/M = -7500$ oersted are detected. Susceptibility measurements at 4.2°K establish an exchange field $H_E = 3.5 \times 10^5$ oersted. The temperature dependence of K_3 was observed from 4.2°K to the transition temperature and compared with spin-wave and molecular field theory. From paramagnetic resonance measurements an isotropic g value of 1.9989 ± 0.003 is determined. Magnetic resonance measurements below the transition temperature with the applied field in the transverse plane show a weak sixfold anisotropy consistent with the torsion measurements. Measurements out of the transverse plane confirm the large axial anisotropy. In the temperature range from 0.3 to 4.2°K there is an additional temperature dependent anisotropy field $H_{A,T} = 9.15/T$ oersted directed along the sublattices. This field arises from the hyperfine interaction with the Mn^{55} nuclear magnetization. Assuming parallel ordering within the transverse planes with adjacent planes alternately magnetized, a calculation of the classical dipolar interactions and of the ligand field anisotropy arising from the displacement of the nearest neighbor fluorines gives a combined axial anisotropy field $K_1/M = -7965$ oersted. The in-plane anisotropy due to second-order dipolar interactions is estimated to be ≈2 oersted in reasonable agreement with observation. The strong coupling between the nuclei and electrons affords an opportunity to observe the Mn^{55} nuclear resonance indirectly by monitoring the position of the electron resonance field. A saturation of the nuclear magnetization is observed at 668 Mc/sec which is (3 ± 1)% smaller than the calculated average hyperfine field of 689 ± 7 Mc/sec. This indicates the presence of a zero-point reduction in the electron spin. (auth)

37853 PARAMAGNETIC RESONANCE OF DYSPROSIUM IN CUBIC AND AXIAL FIELDS IN CaF_2. R. W. Bierig and M. J. Weber (Raytheon Research Div., Waltham, Mass.). Phys. Rev., 132: 164-7(Oct. 1, 1963).

The paramagnetic resonance spectrum of dysprosium in CaF_2 was investigated at 9.6 kMc at liquid-helium temperatures. In a site of cubic crystal-field symmetry, the Dy^{3+} ground state is a Γ_8 quartet. The observed g values and their angular dependences are in general agreement with predicted values derived from Bleaney's Γ_8 spin Hamiltonian. The first excited state is a Γ_7 doublet 8.5 ± 1 cm^{-1} above the ground state with an isotropic $g = 7.52 \pm 0.05$. The fourth and sixth degree parameters describing the cubic crystal field are $A_4\langle r^4\rangle \sim -200$ cm^{-1} and $A_6\langle r^6\rangle \sim 30$ cm^{-1}, respectively. The Dy^{163} hyperfine structure constant determined from the Γ_7 resonance is $(280 \pm 10) \times 10^{-4}$ cm^{-1}. Two groups of lines exhibiting trigonal symmetry about the [111] crystallographic axes are observed with

(I) $g_{\parallel} = 16 \pm 1$, $g_{\perp} < 1$, and (II) $g_{\parallel} = 4.93 \pm 0.05$, $g_{\perp} = 1.50 \pm 0.05$. A site with tetragonal symmetry about [100] axes is also observed with $g_{\parallel} = 1.78 \pm 0.05$, $g_{\perp} = 2.84 \pm 0.05$. Attempts to measure the spin-lattice relaxation time T_1 indicate $T_1 < 3$ μsec at 2°K. Possible relaxation mechanisms and estimates of their magnitude and temperature dependence are discussed. (auth)

37854 ENERGY-FLUX OPERATOR FOR A LATTICE. Robert J. Hardy (Lehigh Univ., Bethlehem, Penna.). Phys. Rev., 132: 168-77(Oct. 1, 1963).

A systematic derivation of the energy-flux operator for a three-dimensional lattice is given. The treatment is based on the general expressions for the energy flux which are valid for all phases of matter; a short derivation of these expressions, making no restrictions to two-body forces, is presented. The average energy flux is transformed to the phonon representation, and it is shown that the diagonal contribution from the harmonic forces has the familiar form $\Sigma_{ks} N_{ks} \hbar\omega_{ks} V_{ks}$. There are in addition nondiagonal contributions to the energy flux, even in the harmonic approximation. The significance of these corrections is discussed. The contributions to the average flux from the anharmonic forces and from lattice imperfections are also treated. The problem of forming wave packets of the plane-wave normal modes to obtain an expression for the local energy flux is considered. (auth)

37855 INTERMEDIATE-STATE REORIENTATION OF NUCLEI ALIGNED IN CERIUM DOUBLE NITRATE. W. W. Strohm, Jr. and R. C. Sapp (Univ. of Kansas, Lawrence). Phys. Rev., 132: 207-14(Oct. 1, 1963).

Radiation patterns and linear polarization of gamma rays from decay of Co^{57} and Ce^{141} aligned at low temperatures by Bleaney's method in cerium double nitrate were studied for evidence of intermediate-state reorientation in this crystal. Influence of spin-spin interactions should be negligible on theoretical grounds. Experimental results, expressed in terms of the mixing ratio $\delta = \pm(E2/M1)^{1/2}$ for the M1 + E2 gamma transitions and of an attenuation coefficient Q_k in the angular distribution $W(\theta) = \Sigma\, Q_k A_k P_k(\cos\theta)$, are as follows: 123-kev gamma from Co^{57} in Ce–Zn nitrate Y sites, $\delta = +0.148 \pm 0.010$, $Q_2 = 0.81 \pm 0.10$ at $1/T^* = 157$; 145-kev gamma from Ce^{141} in Ce–Mg nitrate, $\delta = +0.085 \pm 0.013$, $Q_2 = 1.08 \pm 0.08$ at $1/T^* = 150$. Comparisons are made with Steenberg's theory of intermediate-state reorientation by static, isotropic hfs coupling in the hard-core limit, and with results of other nuclear alignment experiments involving the same isotopes. (auth)

37856 WAVE FUNCTIONS FOR F CENTERS IN MgO. James C. Kemp and Victor I. Neeley (Univ. of Oregon, Eugene). Phys. Rev., 132: 215-23(Oct. 1, 1963).

A calculation of the ground Γ_1^+ and first excited Γ_4^- states of the simple F center in MgO is described, using a mixed linear combination of atomic orbitals point ion lattice scheme. An estimated transition energy of 4.7 ev and oscillator strength near unity is compared with various observed absorption peaks in the middle ultraviolet. Including estimated polarization and deformation corrections, the Γ_1^+ energy E_0 is given, with respect to the vacuum, as $E_0 \lesssim -13.0$ ev, i.e., below the presently assumed valence band maximum of about −9.5 ev. Implications of such a result, e.g., that the O^{2-} vacancy trap may not be bleachable by ionizing radiation, are discussed, especially with reference to mixed electron spin resonance optical experiments. (auth)

37857 FLUORESCENCE OF Dy^{3+} IN CaF_2. Norman Rabbiner (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). Phys. Rev., 132: 224-7 (Oct. 1, 1963).

The fluorescent Spectra I of Dy^{3+} in CaF_2 consisting of approximately 45 lines are found to originate from the crystal-field split levels of the $^4F_{9/2}$ and $^6H_{15/2}$, $^6H_{13/2}$ and $^6H_{11/2}$ free-ion states, in accord with energy-level schemes which indicate the crystal-field symmetry for Spectra I about the Dy ion to be type O_h group. These schemes also give information on the crystal-field energy representations and energies to 3 cm^{-1}, preliminarily. (auth)

37858 ATOMIC BINDING ENERGIES FROM A MODIFIED THOMAS-FERMI-DIRAC THEORY. J. F. Barnes and R. D. Cowan (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 132: 236-40(Oct. 1, 1963). (LADC-5804)

A quantum correction of the statistical model of the atom was obtained by modifying March and Plaskett's region of integration in the (n_r,l), or quantum-number, plane. Integrations over the plane lead, in the unmodified case, to the Thomas-Fermi density expression and energy equation. Integrations over the modified region are here shown to produce a modified Thomas-Fermi expression for the electron density, and a correction to the kinetic energy. The latter correction shows a similarity to the Weizsacker correction, but is smaller by a slowly changing factor of the order of 10. A modified Thomas-Fermi-Dirac equation was derived by the standard variational procedure. Numerical solutions of the equation were obtained, yielding atomic binding energies in much better agreement with experimental values than those of the unmodified theory. (auth)

37859 IONIZATION PRODUCED BY HIGH-ENERGY ATOMIC COLLISIONS. Arnold Russek (Univ. of Connecticut, Storrs). Phys. Rev., 132: 246-61(Oct. 1, 1963).

A statistical theory, developed earlier, to account for the ionization produced by violent collisions between two many-electron atoms is here re-examined in the light of recent experimental results. It is found that the statistical theory is consistent with the concept of an autoionization transition. This transition, which occurs after the collision is over, is between an initial state in the discrete spectrum of the atom and a final continuum state at the same energy. The statistical distributions introduced in the earlier papers are intimately related to the density of final states $\rho(E_f)$ in the standard formula for the transition probability between a discrete level and a continuum: $w = (2\pi/\hbar)\,|H'_{fi}|^2\rho(E_f)$. In addition to reinterpreting the previous results, the statistical theory is here extended and improved, and simple algebraic expressions are obtained for the ionization probabilities. Finally, the ionization process is considered in detail, and a theory for the ionization energies appropriate to violent collisions is presented. It is shown that the appropriate ionization energies increase monotonically with the excitation energy of the autoionizing level and are always larger than the ionization energies as determined spectroscopically. (auth)

37860 CONFIGURATION INTERACTION EFFECTS IN l^N CONFIGURATIONS. K. Rajnak (Univ. of California, Berkeley) and B. G. Wybourne. Phys. Rev., 132: 280-90 (Oct. 1, 1963). (UCRL-10742)

The effects of configuration interactions on the energy-level structure of l^N type configurations were studied. In previous work the linear theory has sought to augment the usual Hamiltonian for an N-electron system with additional two-body scalar interactions. In the present study it is shown that by choosing suitable scalar interactions it is possible to include, to second order, all the electrostatic interactions with configurations having two electrons ex-

cited from the l^N configuration. The form of the scalar interactions, together with expressions for the interaction constants in terms of the radial integrals, was derived explicitly using perturbation theory. Effective three-body interactions are introduced to account for the perturbations due to one-electron excitations. The physical significance of the interaction constants associated with the linear theory is clarified. Formulas are given for the matrix elements of the electrostatic interaction between the l^N configuration and the different species of perturbing configurations. An identity which greatly simplifies the summations arising from the second-order perturbation is established. (auth)

37861 RELATIVE STOPPING POWER OF SOME METALLIC ELEMENTS FOR 28.7-Mev PROTONS. George H. Nakano (Univ. of California, Los Angeles), K. R. MacKenzie, and Hans Bichsel. Phys. Rev., 132: 291-3(Oct. 1, 1963).

The stopping power of Be, Ti, V, Co, Ni, Cu, Ag, Ta, W, Ir, and Au were compared with Al at an average proton energy of 28.7 Mev. Accuracies of 0.25% were obtained by using a scattering foil and subsequent collimation to produce two identical beams. The energy and intensity were continually monitored in one beam. Comparisons were made in the other by rotating the samples to produce small changes in thickness. Anomalously high stopping powers were observed in the transition region where the 3d shell is being filled inside a completed s shell. (auth)

37862 RATIO OF THE EFFECTIVE CHARGE OF He BEAMS TRAVERSING GASEOUS AND METALLIC CADMIUM. W. Meckbach (Centro Atomico Bariloche, San Carlos de Bariloche, Argentina) and S. K. Allison. Phys. Rev., 132: 294-304(Oct. 1, 1963).

By successively measuring the energy degradation of He and H beams of the same velocity in the same Cd foil and in the same Cd-vapor absorber at ~160 μ pressure, ratios of the stopping power for He to the stopping power for H at the same velocity (ϵ_{He}/ϵ_H) and accurate to ~1.3% were obtained. These extend from beam velocities of 1.2 to 3.0 in units of $e^2/\hbar$; in He kinetic energies from 148 to 920 kev, and cover the region in which the square of the effective charge of the beam is changing most rapidly due to electron capture and loss. Comparison of these ϵ_{He}/ϵ_H ratios in the attenuated gas and in the metal should indicate whether the effective number of electrons attached to the He nucleus in the gas remain attached to it as it traverses the metal. The changes found are fractionally much smaller than those found by Lassen in fission fragments, and Roll and Steigert in fluorine ions. For He ions between 575 and 920 kev energy, the effective charge in the gas seems higher than in the solid, constituting a reversal of the anticipated effect. Empirically, a knowledge of ϵ_{He}/ϵ_H ratios is useful for the conversion of data on absolute stopping powers for H into He and vice versa. In the kinetic energy range above 1 Mev per amu, Roll and Steigert and Lassen have found that such ratios for fluorine ions, for instance, fall into two groups characteristic of solids as a class and gases as a class. Comparison of the results reported here with ϵ_{He}/ϵ_H ratios obtained by combining results of various experimenters indicates that such a division is not indicated for ϵ_{He}/ϵ_H ratios at lower energies per amu, but that the difference between solids and gases is comparable to the differences between different metals and different gases. (auth)

37863 DISSOCIATION ENERGY OF $He_2^+(^2\Sigma_u^+)$. P. N. Reagan, J. C. Browne, and F. A. Matsen (Univ. of Texas, Austin). Phys. Rev., 132: 304-7(Oct. 1, 1963).

The potential curve for $He_2^+(^2\Sigma_u^+)$ was calculated using Slater-type orbitals as a basis for a 26 term atomic orbital-configuration wave function. The calculation establishes a rigorous lower bound, $E_{exp}(\text{atoms}) - E_{calc}(\text{molecule})$, of 2.24 ev for the dissociation energy of $He_2^+(^2\Sigma_u^+)$. This value together with the ionization energies of $He^*(2^3S)$ and $He_2^*(^3\Sigma_u^+)$ is used in an energy cycle to give a lower limit of 1.76 ev for the dissociation energy of $He_2^*(^3\Sigma_u^+)$. (auth)

37864 POTENTIAL CURVE OF THE METASTABLE HELIUM MOLECULE. R. D. Poshusta and F. A. Matsen (Univ. of Texas, Austin). Phys. Rev., 132: 307-9(Oct. 1, 1963).

The potential curve of the $He_2(^3\Sigma_u^+)$ molecule was computed using a twelve-term function containing orbitals through 3d. The curve shows a potential maximum near 4.5 a_0 which lies 0.081 ev above the calculated energy of the separated atoms. A similar maximum was obtained in two previous calculations which used a more restricted basis set. The maximum appears to be supported by experiment. In this calculation, $E_{exp}(\text{atoms}) - E_{calc}(r_e) = 0.94$ ev and $E_{calc}(\text{atoms}) - E_{calc}(r_e) = 1.24$ ev. (auth)

37865 SPIN HAMILTONIAN FOR EVEN-ELECTRON SYSTEMS HAVING EVEN MULTIPLICITY. J. S. Griffith (Stanford Univ., Calif.). Phys. Rev., 132: 316-19(Oct. 1, 1963).

The form of spin Hamiltonian necessary to represent the most general zero-field splitting and lowest order magnetic and quadrupole interactions is investigated for systems having an even number of electrons and an even multiplicity. It is shown that, when referred to principal axes, two components of the g tensor are necessarily identically zero. Various other peculiar features emerge. In particular, it is shown that in interpretations of electron spin resonance measurements using a spin Hamiltonian for a non-Kramers doublet, considerable misapprehension and error exist in the literature. (auth)

37866 OPTICAL QUENCHING OF METASTABLE HYDROGEN. Wolfgang Zernik (Radio Corp. of America, Princeton, N. J.). Phys. Rev., 132: 320-3(Oct. 1, 1963).

The theory of the quenching of a metastable atomic state by means of a high-frequency electromagnetic wave is discussed. The particular problem for which numerical results are presented is that of the quenching of the metastable 2S state of atomic hydrogen by means of the light from a ruby laser. The general theory is worked out both by means of the quantum electrodynamical perturbation theory and by means of a strong signal theory. The relation between these two techniques is discussed. (auth)

37867 SEARCH FOR FERROMAGNETICALLY TRAPPED MAGNETIC MONOPOLES OF COSMIC-RAY ORIGIN. Eiichi Goto (Tokyo Univ.), Henry H. Kolm, and Kenneth W. Ford. Phys. Rev., 132: 387-96(Oct. 1, 1963).

Magnetic monopoles, if they exist, should be trapped and accumulated in ferromagnetic materials. Using the high field of a pulsed magnet, extraction of monopoles from a magnetite outcrop on the earth's surface and from fragments of a stony-iron meteorite was attempted. In the nuclear emulsions used for detection, no tracks were found satisfying the geometric criteria and having an energy-loss rate compatible with the theoretical expectation for monopoles. The area-time product of the magnetite cosmic-ray exposure is estimated to be about 10^{13} cm^2 sec. From the negative results, upper-limit monopole production cross sections in the atmosphere are estimated as a function of assumed monopole mass. (auth)

37868 THE DIPOLE POLARIZABILITY OF MEMBERS OF THE LITHIUM SEQUENCE. M. R. Flannery and A. L.

Stewart (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 82: 188-91(Aug. 1, 1963).

The dipole polarizabilities of normal Li, Be^{+}, ..., F^{6+} are determined using perturbed and unperturbed wave functions of the open shell type. The result for lithium, $\alpha = 25.1 \times 10^{-24}$ cm^3, is in agreement with theoretical estimates, but slightly in excess of the measurement $\alpha = 22 \pm 2 \times 10^{-24}$ cm^3. (auth)

37869 THE INFLUENCE OF CLOSE COUPLING ON THE THRESHOLD BEHAVIOUR OF CROSS SECTIONS OF ELECTRON-HYDROGEN SCATTERING. M. Gailitis and R. Damburg (Inst. of Physics, Riga). Proc. Phys. Soc. (London), 82: 192-200 (Aug. 1, 1963).

The behavior of cross sections in the neighborhood of thresholds depends on the character of the interaction of particles at large distances. For the short-range forces, the inelastic cross sections depend on energy as $k_f^{2l_f+1}$ where k_f, l_f are the momentum and angular momentum in the final state. The threshold behavior for electron–hydrogen scattering is studied, where an essential influence is exerted by close coupling, which leads to long-range forces. It is found that for electron–hydrogen scattering the $k_f^{2l_f+1}$ dependence no longer holds, because of the strong polarization interaction produced by the colliding electron when the hydrogen atom is in the excited state. Cross sections in the neighborhood of the threshold oscillate. Inelastic cross sections approach zero only at an energy above the threshold of the order of the relativistic splitting between levels. (auth)

37870 ON THE INSTABILITY OF A CLASS OF UNITARY FIELD MODELS. R. H. Hobart (Dalhousie Univ., Halifax, Novo Scotia, Can.). Proc. Phys. Soc. (London), 82: 201-3(Aug. 1, 1963).

A general instability of non-singular, time-independent radial solutions to equations of the form $\nabla^2\phi = f(\phi)$ is shown. (auth)

37871 A MONTE CARLO CALCULATION OF THE SPATIAL DISTRIBUTION OF CHARACTERISTIC X-RAY PRODUCTION IN A SOLID TARGET. M. Green (Cambridge Univ., Eng.). Proc. Phys. Soc. (London), 82: 204-15 (Aug. 1, 1963).

Electron trajectory models of increasing complexity can be used to calculate the spatial distribution of the K-shell ionization produced in a target by direct electron impact. The models are discussed and compared with a model suitable for use in a Monte Carlo calculation. This type of calculation is carried out with experimental scattering data, and results are presented for the case of a copper target bombarded by a 29-kev electron beam. (auth)

37872 MAGNETOHYDRODYNAMICS. T. G. Cowling (Univ. of Leeds, Eng.). Rept. Progr. Phys., 25: 244-86 (1962).

The theoretical aspects of magnetohydrodynamics are discussed. Phenomena treated include those associated with liquid flow, ionized gases, and the geophysical effects of the solar emission of charged particle streams. Some experimental work is also reviewed. 122 references. (D.C.W.)

37873 SHOCK WAVES IN GASES. H. J. Pain and E. W. E. Rogers (Imperial Coll. of Science and Tech., London and National Physical Lab., Teddington, Middx., Eng.). Rept. Progr. Phys., 25: 287-336(1962).

The characteristics of several geometric forms of shock wave that occur in a perfect gas are discussed. The behavior of shock waves undergoing reflection and diffraction is discussed with particular reference to the Mach-type reflection. The structure of the normal shock wave, from the standpoint of both continuum and kinetic theories, is considered, and progress in the field of shock-wave and boundary-layer interaction is reviewed. The application of shock-wave techniques to problems which interest physicists and physical chemists is also considered. The generation of strong shock waves in pressure-driven and electromagnetic shock tubes is discussed, and an account is given of the effect of these waves upon atomic and polyatomic gases with particular reference to ionization, dissociation and internal energy relaxation. The more complex behavior of shock waves travelling through ionized gases of low and high number density is also examined. 180 references. (auth)

37874 HIGH INTENSITY SOURCE OF 20-kev HYDROGEN ATOMS. Frank J. Gordon and Charles C. Damm (Univ. of California, Livermore). Rev. Sci. Instr., 34: 963-70(Sept. 1963). (UCRL-7095-T)

A continuous source of energetic hydrogen atoms was developed for use in a plasma experiment. The mechanical design and some operating characteristics of the ion source are described, as well as the beam focusing and neutralizing system. An output of 65-ma power equivalent of 20-kev hydrogen atoms was measured on a 2.0×6.3 cm target located 350 cm from the ion source. (auth)

37875 USE OF AN ANALOG-TO-DIGITAL CONVERTER IN PULSED NUCLEAR RESONANCE. E. O. Stejskal (Univ. of Wisconsin, Madison). Rev. Sci. Instr., 34: 971-5(Sept. 1963).

The use, in pulsed nuclear resonance experiments, of a voltage-to-frequency converter and an electronic counter to act as an integrator for the observed signals is described. Because measurements of this type are free of most subjective influences, they improve upon continued replication. Data are obtainable in a form which may easily be processed by a digital computer. Increased accuracy and sensitivity are the result. Sample T_1 determinations are presented. The relaxation in a sample showing a single T_1 is followed to within one part in 10^4 of equilibrium. Remarks are made concerning the design and use of a calibration equation capable of accounting for the behavior of a vacuum tube diode detector biased for linear operation. (auth)

37876 ANALYTIC REPRESENTATION OF ATOMIC SCATTERING FACTORS FOR ELECTRONS. F. A. Brusentsev and V. F. Dvoryankin (Inst. of Inorganic Chemistry, Siberian Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 197-8(Sept.-Oct. 1963).

Electronic computers have made it possible to represent atomic scattering factors in analytic form, and several equations have been proposed for use with x rays and electrons to give the scattering factor as a function of $x = \sin\theta/\lambda$. A polynomial of ninth degree was chosen for highest accuracy with a minimum number of coefficients in the expression. The atomic factors for Li, Cr, and Fm are given with relation of error to degree of polynomial taken. (R.E.U.)

37877 ROLE OF SECONDARY EMISSION PHENOMENA IN THE X-RAY PHOTOEFFECT IN METALLIC CATHODES. M. A. Rumsh and V. N. Shchemelev (Leningrad State Univ.). Soviet Phys.-Solid State (English Transl.), 5: 46-50(July 1963).

An instrument designed for current measurements of the x-ray photoeffect and energy analysis of the x-ray photoemission is described. The quantum-yield current is given

for a number of metals. Comparison of the current and pulse quantum yields permits the determination of the mean multiplicity of x-ray photoemission. Study of the energy composition of x-ray photoemission gives information on the role of secondary-emission processes in x-ray photoemission phenomena and leads to a new method of determining the multiplicity of the elementary act. (auth)

37878 NUMERICAL CALCULATIONS OF THE RESONANCE BEHAVIOR OF SCATTERING CROSS SECTIONS OF ATOMIC COLLISIONS. [PART] I. R. Dueren and H. Pauly (Universität, Bonn). Z. Physik, 175: 227-34 (1963). (In German)

The semiclassical approximation can be used to calculate the extremes in the energy dependence of the total cross section for collisions between neutral atoms and molecules. For this treatment, the classical deflection function $\Theta(\beta)$ must be known in the region near β_0, where it passes smoothly through 0° (glory scattering). Numerical values for β_0, $\Theta'(\beta_0)$, and $\Theta''(\beta_0)$, which determine the amplitude of the extremes are presented for a Kihara (12.6) potential for various reduced energies K ($0.01 \leq K \leq 100$) and potential parameters $\alpha(-0.3 \leq \alpha \leq 0.5)$. (auth)

37879 QUANTUM THEORY OF TIME MEASUREMENT. Eugen Fick and Folker Engelmann (Universität, Würzburg, Ger. and Euratom-CNEN, Rome). Z. Physik, 175: 271-82(1963). (In German)

As a consequence of its dynamical motion a quantum mechanical system may be considered as a quantum mechanical clock. If it is demanded that the time be an observable that corresponds to a hypermaximal time operator in Hilbert space, then, for systems having a continuous energy spectrum with a lower limit, in the framework of the nonrelativistic theory there must exist an upper limit of energy, too. Furthermore the time operator is not defined on the whole Hilbert space, but only on state functions satisfying a certain condition. Therefrom it results that a quantum mechanical clock of this kind can be read off only in a sequence of equidistant times separated by a "minimal time." The beginning of the time measurement being arbitrary the scale of time may be shifted according to the homogeneity in time. For a free particle in addition to the minimal time a minimal length was also obtained. The equidistant scale in space is not absolute, but permits an arbitrary choice of the point of reference according to homogeneity in space. The modificated spreading of the probability distribution of particle position is discussed. (auth)

37880 MEASUREMENT OF ELECTRON SHOWERS IN LEAD AND COPPER WITH THE HELP OF A BUBBLE CHAMBER. H. Lengeler, W. Tejessy, and M. Deutschmann (Technische Hochschule, Aachen and Universität, Bonn). Z. Physik, 175: 283-99(1963). (In German)

A propane bubble chamber containing lead or copper plates was used to study the development of cascade showers initiated by electrons with energies of 372, 192, and 92 Mev. For each set of absorbers and each energy the mean number of electrons as a function of the depth was determined. The number of showers was sufficiently large to additionally allow measurement of the fluctuations and the angular distribution of the electrons at various depths. Comparison of the data with conventional theories showed poor agreement whereas the agreement with Monte Carlo calculations by Nagel and by Zerby was satisfactory. (auth)

37881 THE DETERMINATION OF THE FREQUENCY FACTOR AND THE TRAP DEPTH FROM THE TEMPERATURE DEPENDENCE OF THE ELECTROLUMINESCENCE OF ZnS PHOSPHORS. Dietrich Hahn and Wolfgang Kernchen. Z. Physik, 175: 300-13(1963). (In German)

The temperature dependence of the a-c electroluminescence of ZnS-phosphors showed characteristic features which are closely related to the energetic distribution of traps. Measurements over a wide range of exciting field frequencies were used to determine frequency factors and trap depths with high accuracy. The order of magnitude of the obtained frequency factors agreed with theoretical values and results of other authors, who investigated CdS single crystals by different methods. The trap depths resulting from electroluminescence measurements were lower than those estimated from glow curves. This deviation can be explained by considering multiple retrapping and a low quantum efficiency of the thermoluminescence. An expression for the trap depth in dependence of the temperature of a glow maximum was derived, which is valid for all kinetics of thermoluminescence. (auth)

37882 TRAP FILLING BY FIELD EXCITATION OF ELECTROLUMINESCENT CENTERS IN ZINC SULFIDE PHOSPHORS. Dietrich Hahn and Wolfgang Kernchen (Physikalisch-Technischen Bundesanstalt, Berlin). Z. Physik, 175: 314-26(1963). (In German)

Traps of electroluminescent ZnS phosphors can be filled by field excitation at low temperatures as was indicated by thermoluminescence. Shape and light sum of the resulting glow curves were similar to those produced after very feeble uv excitation. Regarding the same luminance of the phosphor the efficiency of the trap filling by field excitation was found to be only a small fraction of that by uv excitation. The time dependence of field induced trap filling can be expressed by an exponential law. The voltage as well as the frequency dependence of the trap filling differed from that of the luminescence intensity. The results can be explained by the fact that electroluminescence excitation only occurs in small parts of the crystallites. It is supposed that the saturation of trap filling in these areas is achieved within a short time whereas trap filling in the bulk is performed by a slow diffusion process. (auth)

37883 FLUCTUATIONS OF ELECTRON-PHOTON SHOWERS IN XENON. B. Nichiporuk and Z. S. Strugalskii (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 13-17(Aug. 1963). (In Russian)

Fluctuations along 4 Bev total energy electron-photon showers in xenon are studied with a bubble chamber. (auth)

37884 EFFECT OF COLLISIONS ON THE EXCITATION SPECTRUM OF A SYSTEM OF ELECTRONS. Yu. Ya. Polyak and V. M. Eleonskii (Ural Div., Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 159-63(Aug. 1963). (In Russian)

An expression for the longitudinal dielectric constant of a system of electrons is obtained in the hydrodynamic approximation by taking into account the effect of space dispersion on electron-ion and electron-electron collisions. It is shown that when space dispersion is taken into account electron-ion as well as electron-electron collisions become important, and that in the presence of space dispersion collision damping leads to a small shift of the proper frequencies of the electron oscillations. (auth)

37885 CHARGE EXCHANGE IN THE CASE OF A SMALL RESONANCE DEFECT. Yu. N. Demkov (Leningrad State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 195-201(Aug. 1963). (In Russian)

A general formula for the probability of electron charge exchange is obtained for the case when the change of the electron energy is small compared with the distance from the closest levels in the two atomic systems. The deduction of the formula is analogous to that of the Bohr quantum conditions in the semi-classical method. For a special case a similar result has been obtained by Zener and Rosen. The significance of the Massey criterion, which determines the position of the effective cross section peak, is examined in greater detail and the oscillating nature of the differential cross section, which is similar to that in the case of resonance charge exchange, is established. The results can also be applied to a number of other processes such as excitation transfer between s states during the collisions between atoms or ions. (auth)

37886 AN OPTIMAL SYSTEM OF BASIS FUNCTIONS IN THE THEORY OF COLLISIONS BETWEEN ELECTRONS AND ATOMS. B. A. Veklenko and A. N. Starostin (Moscow Inst. of Power Engineering). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 260-7(Aug. 1963). (In Russian)

Solution of collision problems by expanding the wave function of the system into a set of eigenfunctions of the unperturbed atom hamiltonian is not optimal with respect to rapidity of convergence of the series. An equation set is obtained that defines the optimal basis and the expansion coefficients for the Ψ function in terms of this basis. Concrete calculations of phase shifts are carried out for elastic scattering of low energy electrons by the hydrogen atom. (auth)

37887 ON CRITICAL MAGNETIC FIELDS IN SUPERCONDUCTING BERYLLIUM FILMS. B. G. Lazarev, E. E. Semenenko, and A. I. Sudovtsev (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 391-2(Aug. 1963). (In Russian)

Under certain condensing conditions Be films form two superconducting modifications with different superconductivity temperatures (near 8 and 6°K) and are not able to withstand higher temperatures. Magnetic fields effects on superconductivity in films prepared by liquid helium cooling and condensation were studied. Measurements on two superconducting modifications ($T_c \sim 6.5$°K) showed that the field effects in freshly condensed films were quite extensive ($dH_c/dT \sim (32 \text{ to } 34) \times 10^3$ Gauss/deg). The thickness of the film did not effect dH_c/dT in Be, while in Tl films the dH_c/dT was considerably reduced at increased thicknesses. It was also noticed that the dH_c/dT in Be was considerably higher than in Nb_3Sn (10000 Gauss/deg). (R.V.J.)

37888 RAYLEIGH'S PROBLEM IN MAGNETOGASDYNAMICS. Pau-chang Lu. Thesis, Cleveland, Case Inst. of Tech., 1963. 151p.

The velocity, temperature, and magnetic-field distributions in a compressible and viscous fluid, both thermally and electrically conducting, induced by the impulsive motion of an infinite flat plate in its own plane were obtained by applying the inner-outer expansion technique of Kaplun, Lagerstrom, and Cole. The problem is discussed in general terms without reference to specific wall conditions and conductivity laws. Details are given for the limiting case of infinite conductivity, as well as for seeded argon at about 2500°K. This latter case was made as realistic as possible without complicating the numerical computations too much. The numerical results serve to show the practicability of the technique and the qualitative behavior to be expected in similar cases. The importance of treating the orders of magnitude of governing parameters relative to the magnetic Prandtl number is emphasized. (Dissertation Abstr.)

37889 A STUDY OF SUPERCONDUCTIVE NEURISTORS. François Antoine Lucien Padovani. Thesis, Stanford, Calif., Stanford Univ., 1963. 71p.

The "Neuristor," a class of active devices as proposed by H. D. Crane, is recalled. A superconductive neuristor is introduced. It is shown that a structure, consisting of a normal film connected to a superconductive film carrying a direct current, presents neuristor-like properties. A mathematical model of this neuristor is presented. It is shown that the propagation of a discharge along this structure can be represented by a system of two nonlinear differential equations. One of these equations describes the temperature variations of the film during the passage of a discharge; the other one, the current variations. The simulation of these equations on an analog computer is presented and an order of magnitude of the different parameters involved in the mathematical model is obtained. The design of an experimental device is presented. The substrate and the superconductive materials are selected, together with the thickness of the superconductive film. The width of this superconductive film is evaluated for the two possible practical realizations. It is shown that both of these devices lead to easy-to-build junctions. The experimental situation is also presented. The experimental apparatus, the evaporator and the liquid helium system, is discussed. The results obtained in the study of the spreading of a normal region in a superconductive tin, 1,000 Å thick and carrying a direct current, are presented. The technical difficulties encountered in attempting to produce a neuristor structure are described. (Dissertation Abstr.)

37890 DYNAMIC NUCLEAR ORIENTATION AND SPIN-LATTICE RELAXATION OF Co^{59}. Wesley Paul Unruh. Thesis, Univ. of Kansas, 1962. 126p. Lawrence, Kan.,

A study was made of dynamic nuclear orientation of (stable) Co^{59} in double nitrates. Both Jeffries and Overhauser processes were investigated in an effort to understand the nature of the various spin-lattice relaxation processes within a resolved hyperfine structure which can lead to nuclear orientation. These processes are reviewed for the case of an effective spin $\frac{1}{2}$ ion with resolved hyperfine structure, and the effects of competing hyperfine relaxation are discussed. Since orientation experiments with radioactive isotopes generally do not give the nuclear substate populations directly, a double frequency microwave method was used in which these populations can be measured directly. Populations were measured with a paramagnetic resonance spectrometer (operated at low power) which determined the relative intensities of the hyperfine lines before and after orientation was produced with a separate microwave pump system. The ratio of hyperfine relaxation rates for $\Delta m = 0$ and $\Delta m = \pm 2$ processes was determined from measurements of the Overhauser effect, while relative speeds of the allowed electronic and the hyperfine relaxation rates could be determined from the saturation effects which accompanied Jeffries orientation. The direct electronic relaxation rates ($\Delta m_S = \pm 1$, $\Delta m_I = 0$) were measured by the pulsed microwave method. The measurements were made at 1.2°K, with cobalt fractional concentrations of from 0.5 to 0.005%. A phenomenological model for the results is presented, in which spin-lattice relaxation is described by a fluctuating g- and A-tensor, both of which are random time functions. Relaxation rates are given in terms of spectral densities of the various components of the tensors. This model fits the data well, and the resulting

spectral densities can be related to the phonon spectrum in the crystal through a suitable model for the spin-phonon interaction. The values obtained in this case imply that low-symmetry distortions of the cobalt complex predominate, while purely trigonal distortions are far less probable. The complexity of the observed relaxation shows that it will generally be impossible to interpret the results of a dynamic orientation experiment unless the various relaxation processes involved are previously measured experimentally. In particular, the assumption of a dominant direct relaxation and vanishing $\Delta m = \pm 2$ hyperfine relaxation cannot be relied upon. (Dissertation Abstr.)

37891 A QUANTUM MECHANICAL CALCULATION OF THE THIRD VIRIAL COEFFICIENT OF He^4. Sigurd Yves Larsen. Thesis, New York, Columbia Univ., 1962. 60p.

Using the method of Binary Collisions, the third virial coefficient of He^4 at low temperatures was calculated for a simple potential consisting of an attractive square well and a repulsive core. The shape of this potential was chosen so as to optimize the fit of the second virial coefficient with experimental data. From a comparison of the results with the third virial data the existence of a three-body bound state was inferred. A binding energy of 0.26°K, calculated from the potential, brings the adjusted results and the experimental data into agreement. (Dissertation Abstr.)

37892 IMPROVEMENTS IN NEUTRON SOURCES. Saadia Amael and Aharon Nir. British Patent 933,429. Aug. 8, 1963. Priority date June 6, 1961, Israel.

An (α,n) source, consisting of an α-particle emitter and an oxygenous target material capable of emitting neutrons upon incidence of the α particles, is patented. The α emitter and the target can be brought together to produce neutron emission or moved away from each other to stop neutron emission. The target material may be water enriched in O^{18}, gaseous O enriched in O^{18}, or an oxygenous compound such as a metal oxide of increased O^{18} content. The α-neutron source is particularly efficient when the O^{18} content of the target material is at least 50% of the total O. (M.P.G.)

Astrophysics, Cosmology, and Geophysics

37893 (AFCRL-62-352) RADAR OBSERVATIONS OF FIELD-ALIGNED IRREGULARITIES DURING THE TWO MAGNETICALLY DISTURBED DAYS, MAY 6, 1960 AND MAY 8, 1960. Scientific Report No. 15. Evelyn M. Matthews and E. W. Dearden (Queensland, Australia. Univ., Brisbane). Mar. 1962. Contract AF64(500)-9. 35p. (AD-294699)

Further evidence is presented for an association between the outer Van Allen Belt, the FAI arcs observed from Brisbane, and the 6300 Å airglow arcs. The phenomena associated with a discontinuous increase in the northward speed of an FAI arc are studied, and the event is interpreted as arising from some form of impact on the magnetosphere. The occurrence of an annular echo and its associated phenomena is interpreted as an observation of the Outer Belt dumping radiation into the atmosphere. (auth)

37894 (NASA-TR-R-181) EFFECT OF UNIFORM EXTERNAL PRESSURE AND OBLIQUE INCIDENCE OF THE SOLAR WIND ON THE TERMINAL SHAPE OF THE GEOMAGNETIC FIELD. John R. Spreiter and Audrey L. Summers (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.). 1963. 35p.

Approximate solutions and numerical results are given for the coordinates of the boundary separating the geomagnetic field from the interplanetary plasma for a ±35° range of angles between the direction of the incident stream and the geomagnetic equatorial plane for a model that assumes the plasma pressure exerted on the boundary to be composed of a dynamic pressure, proportional to the normal component of the momentum of the plasma particles, and a static pressure considered constant over the entire boundary. Results are presented for a complete range of values for the ratio between the two pressure components. (auth)

37895 THEORY OF THE STATIONARY PROPERTIES OF THE COMPLETELY IONIZED PLASMA AROUND THE EARTH. A. A. Vlasov and F. Kh. Khakimov (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 151: 818-21(Aug. 1, 1963). (In Russian)

In order to determine the existence of a specific, statistically formed radiation belt around the earth, the ellipsoidal character of the high-altitude distribution must be considered, together with the reaction of this distribution on the effects of the external (dipole) magnetic field of the earth, the interaction of the charged particles with each other and with the charge of the earth and its atmosphere. These factors point to a marked spatial anisotropy in the distribution of the electrons and the nuclei; this may be calculated and the theoretical values may be compared with the experimental data on the earth radiation belts. The constant of ellipsoidity may be determined from the concentration and the temperature of the particles in a single point of the space, as indicated previously (Zhur. Tekh. Fiz. 795 (1961) No. 7). The calculations point to the presence of a belt with a predominance of nuclei over electrons; beyond this belt, there are mostly only electrons. The solution derived satisfies the requirement of the neutrality of the overall system which consists of the earth, the atmosphere, and the completely ionized plasma surrounding the earth. In the calculations it was assumed that the rotational and magnetic axes coincide. (TTT)

37896 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln, ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 5307-10(Sept. 15, 1963).

Some recent data on geomagnetic and solar activity are compiled. (D.C.W.)

37897 NOTE ON LOW-LEVEL GEOMAGNETIC RING-CURRENT EFFECTS. E. H. Vestine (RAND Corp., Santa Monica, Calif.). J. Geophys. Res., 68: 4897-4907(Sept. 1, 1963).

Various measurements of the intensity of radiation within the inner Van Allen belt have indicated little possibility that the equatorial magnetic field of the belt should exceed 0.5 γ. The 12-year means of geomagnetic disturbance data show an equatorial latitude variation, which could arise from a transient equatorial ring current at a height within the outer reaches of the inner belt. This small transient equatorial ring current may be introduced to suitable equatorial heights by downward expansion of a higher ring current present during magnetic storms. This possibility would be susceptible of experimental check. Another possibility is increased westward current flow within the equatorial ionosphere or enhanced compression of the equatorial magnetosphere during storm days. (auth)

37898 PERIODIC VARIATIONS OF THE ENERGY SPECTRUM OF AURORAL ZONE X RAYS. H. Trefall and

K. Bårdsen (Univ. of Bergen, Norway). J. Geophys. Res., 68: 4909-16(Sept. 1, 1963).

Quasi-periodic variations of the energy spectrum of auroral zone x rays have been observed during a balloon flight from Andenes in northern Norway. Several bursts of electron bremsstrahlung were recorded during that flight. By comparing the counting rates of two Geiger counters with different energy responses, it was found that the x-ray spectrum frequently varied in a nearly periodic manner with periods from 4 to 7 minutes. No corresponding variations of the x-ray intensity itself were observed. It is suggested that the observed spectral variations may have been caused by hydromagnetic waves in the magnetosphere, through a violation of the third adiabatic invariant. (auth)

37899 A COMPARISON OF METHODS USED FOR OBTAINING ELECTRON CONTENT FROM SATELLITE OBSERVATIONS. O. K. Garriott (Stanford Univ., Calif.) and F. de Mendonça. J. Geophys. Res., 68: 4917-27(Sept. 1, 1963).

Measurements of the effects of the ionosphere on the polarization and the Doppler shift of radio transmissions from earth satellites permit the electron content of the ionosphere to be calculated. Thirty-five passages of Transit 2A have been analyzed in a variety of ways to estimate the accuracy of the several methods. The most accurate method is a hybrid analysis using both Faraday and Doppler data simultaneously. Methods based on the rate of polarization rotation, on the number of rotations between two times, and on best-fitting polynomials to either the Faraday or the Doppler data are compared and their errors estimated. (auth)

37900 AIR-BLAST COUPLING TO PROGRADE AND RETROGRADE SURFACE WAVES. G. H. S. Jones, G. T. Maureau, and S. A. Cyganik (Suffield Experimental Station, Ralston, Alta.). J. Geophys. Res., 68: 4979-87(Sept. 1, 1963).

It is shown that on the Suffield test site surface-burst charges of TNT generate a dispersed surface wave directly in the ground, which may be either prograde or retrograde, and, at the same time, an approximately constant-frequency air-coupled wave. The phase relation between the air-coupled wave and the dispersed wave is sensitive to slight changes in the dispersive properties of the layered mediums. Comparison is made with the prograde and retrograde pulses generated by buried charges, and the seismograms from the large charge series are supplemented by synthetic seismograms produced by adding the air-coupled train from small surface-burst charges to the dispersed train produced by small contained charges. (auth)

37901 SURFACE WAVE RADIATION PATTERNS FOR UNDERGROUND NUCLEAR EXPLOSIONS AND SMALL-MAGNITUDE EARTHQUAKES. James N. Brune and Paul W. Pomeroy (Columbia Univ., Palisades, N. Y.). J. Geophys. Res., 68: 5005-28(Sept. 1, 1963).

The surface wave radiation patterns (amplitude and initial phase) were determined for several of the larger underground nuclear explosions in Nevada. Initial phases of surface waves from explosions and earthquakes were obtained by performing a Fourier analysis of the record and equalizing the phase to the source, using long-period records from the temporary long-range seismic measurement stations installed by the Geotechnical Corporation. Rayleigh waves from explosions in tuff and alluvium appear to have nearly the same initial phase at all azimuths, indicating an explosive force acting as a step function in time as the probable approximate source mechanism. However, the presence of Love waves, along with some asymmetry in Rayleigh wave amplitudes, indicates that some asymmetrical forces are also acting at the origin. The collapses following these explosions generate Rayleigh waves with polarities apparently reversed from those of the explosions. The collapses generate much weaker Love waves relative to Rayleigh waves than the explosions, and therefore the Love waves must be generated at or very near the source. The one explosion in granite (Hardhat) gave a surface wave radiation pattern with double-couple symmetry in both phase and amplitude, a symmetry very different from that found for the explosions in tuff and alluvium. Such a radiation pattern cannot be explained by a simple, symmetric explosive force. Several explanations of this double-couple symmetry are considered, including the possibilities that the surface waves were generated by cracking or forced motion along pre-existing cracks, tectonic strain release resulting from cavity formation, or, more probably, triggering of tectonic motion. The latter hypothesis would explain the radiation pattern, and it is supported by the occurrence of an aftershock sequence, outside the cavity zone, similar to that common for earthquakes. Analysis of surface waves from earthquakes indicates that, in many cases, the earthquake sources are more complicated than the explosion sources. The information about source mechanisms obtained in this study is of fundamental importance to the problem of the identification of explosions and earthquakes. (auth)

37902 RESULTS OF RIOMETER MEASUREMENTS AT ROCKPORT, MASSACHUSETTS, DURING THE HIGH-ALTITUDE NUCLEAR EXPLOSION ON JULY 9, 1962. Daniel W. Swift (Avco Corp., Wilmington, Mass.). J. Geophys. Res., 68: 5093-6(Sept. 1, 1963).

The results of riometer measurements at Rockport, Massachusetts, are given for a period of time before, during, and after the detonation of a 1.4-megaton nuclear device over Johnston Island on July 9, 1962. The results indicate an increased absorption by the ionosphere of normal atmospheric noise. Explanations are proposed for this phenomenon. (R.E.U.)

37903 CALCULATION BY A MOMENT TECHNIQUE OF THE PERTURBATION OF THE GEOMAGNETIC FIELD BY THE SOLAR WIND. J. E. Midgley and L. Davis, Jr. (California Inst. of Tech., Pasadena). J. Geophys. Res., 68: 5111-23(Sept. 15, 1963).

The moment technique, used earlier to solve the problem of a dipole in a uniform pressure plasma, is extended to the problem of a dipole of moment Me_Y in a cold, field-free plasma wind with density N_0M_i and velocity $-U_0e_z$. An assumed surface and current system containing 46 parameters is specified in such a way as to always have the local current density proportional to the cosine of the angle made by the wind and the surface normal, as required by the boundary conditions. The parameters are varied until the magnetic multipole moments of the surface currents approximately cancel the corresponding moments of the magnetic sources within the surface making the field zero outside. The resulting approximate solution of the exact boundary condition is compared with the exact solution of Beard's approximate boundary condition. In a coordinate system (x,y,z) centered at the dipole, the neutral points, where the surface is parallel to the wind direction, occur at the points $(0, \pm R_N, 0.27\ R_N)$, and other points on the surface are $(0, 0, 1.02\ R_N)$, $(0, \pm 2\ R_N, -\infty)$, and $(\pm 1.97\ R_N, 0, -\infty)$. $R_N = 1.0035[M/(M_iN_0U_0^2)^{1/6}]^{1/3}$ is about nine earth radii for the solar wind. Plots of the surface and the current

lines are given, and the perturbation of the magnetic field within the cavity is calculated. (auth)

37904 CONTRIBUTION OF ENERGETIC PHOTOELECTRONS TO D-REGION NONEQUILIBRIUM ELECTRON TEMPERATURES. Robert D. Sears (Illinois Inst. of Tech., Chicago). J. Geophys. Res., 68: 5135-42(Sept. 15, 1963).

The electron equilibrium energy in the D and lower E region of the ionosphere is calculated from a relation between electron energy loss and attachment characteristic times. It is shown that solar photodetachment of electrons from O_2^- ions, which is the major short-term ionization source between 50 and 90 km, is a source of energetic electrons of 2.9-ev mean energy. Thus competition between energy loss by rotational excitation of molecules and dissociative attachment to oxygen will exist as the most probable processes for 3-ev electrons. Approximate conditions are defined that allow calculation of maximum mean electron energy at equilibrium for the undisturbed or slightly disturbed daytime ionosphere. Comparison of these maximum values with a measured electron energy of 0.15 ev at 40 km shows agreement within a factor of 2, which may be accounted for by the disturbed condition of the ionosphere during the measurement. The range of maximum permissible electron energies lies between 1.2 times ambient at 30 km and 42 times ambient (0.74 ev) at 90 km. A method is outlined whereby one parameter among the set — equilibrium electron energy, energy loss characteristic time, or electron removal characteristic time — can be determined if the other two can be found experimentally and if the mean source energy of the electrons is known. Thus radio measurement techniques such as the Luxembourg effect or rocket probes can be used to relate temperature measurements and electron-density measurements through a reaction model based on estimation of characteristic times of competing processes. (auth)

37905 BOLOMETRIC-CORRECTION AND EFFECTIVE-TEMPERATURE SCALE. Robert L. Wildey (California Inst. of Tech., Pasadena and Carnegie Institution of Washington, D. C.). Nature, 199: 988-90(Sept. 7, 1963).

Applications of high-speed digital computers to problems in theoretical astrophysics, combined with fundamental research in nuclear physics and solar convection, to achieve understanding of the physics of stellar interiors and stellar evolution are discussed. It is pointed out that the scale of bolometric-corrections (B.C.) and effective temperatures (Te) is the connecting link between theory and observations in this field. Results are presented from an attempt to compile the most reliable set of B.C.'s and Te's from the literature. (C.H.)

37906 DIRECT MEASUREMENTS OF HELIUM AND HYDROGEN ION CONCENTRATION AND TOTAL ION DENSITY TO AN ALTITUDE OF 940 KILOMETERS. H. A. Taylor, Jr., L. H. Brace, H. C. Brinton, and C. R. Smith (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 68: 5339-47(Oct. 1, 1963).

A Bennett-type ion mass spectrometer and a cylindrical electrostatic probe were carried to 940 km above Wallops Island, Virginia, at midday in October 1961. The raw data from each unit (ion currents versus altitude) are presented and are interpreted in terms of helium, hydrogen, oxygen, and total ion concentration. The He^+ and H^+ concentrations derived from the ion mass spectrometer experiment were found to rise steeply above 350 km, He^+ reaching a maximum value of 7×10^3/cc at 575 km and H^+ increasing monotonically with altitude, ultimately reaching 1.5×10^3/cc near apogee. These data are used with the O^+ concentrations derived from the electrostatic probe data to calculate the atmospheric temperature, the mean ion mass, and the total ion concentration as functions of altitude. The temperature of the upper F region was found to be 1235 ± 40°K. The mean ion mass decreased from 16 AMU at 400 km to 12 AMU at apogee where it was decreasing rapidly. The measured ion distributions and those predicted by the theories of hydrostatic diffusion and ion-atom interchange are compared. (auth)

37907 IONOSPHERE ELECTRON TEMPERATURE MEASUREMENTS AND THEIR IMPLICATIONS. L. H. Brace (Goddard Space Flight Center, Greenbelt, Md.), N. W. Spencer, and G. R. Carignan. J. Geophys. Res., 68: 5397-5412(Oct. 1, 1963).

Electron temperature and ion density data are reviewed in terms of their consistency with recent theories regarding thermal equilibrium in the daytime ionosphere. On the basis of these daytime data and the ionosphere theory, it is concluded that solar extreme ultraviolet radiation (EUV) is the dominant heat source in the quiet midlatitude ionosphere. This conclusion is suggested by the agreement between the electron temperature profiles measured under these conditions and theoretically predicted profiles based on EUV radiation as the only heat source. Measurements in the disturbed midlatitude and auroral zone ionospheres suggest that, although EUV remains the dominant heat source for electrons in the F_1 region, an additional heat source is effective in the E and F_2 regions. Its effect is to extend the region of thermal nonequilibrium both upward into the upper F region and downward into the E region. The results of a more recent flight in the nighttime ionosphere are presented and discussed. A horizontal gradient in electron temperature found in the nighttime ionosphere is believed too abrupt to permit a similar gradient in the gas temperature and thus indicates that small but variable degrees of thermal nonequilibrium can exist in the nighttime ionosphere. This is believed to be because of particle fluxes whose heating effects are enhanced by the low values of electron density existing in the nighttime F region. (auth)

37908 VERY-LOW-FREQUENCY PHASE OBSERVATIONS OF SOLAR FLARE IONIZATION IN THE D REGION OF THE IONOSPHERE. C. J. Chilton, F. K. Steele, and R. B. Norton (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 5421-35(Oct. 1, 1963).

Sudden phase anomalies produced by solar flares were observed simultaneously on several long v-l-f propagation paths. The observations show that during a solar flare the magnitude of the mean change of reflection height Δh on each sunlit path can apparently be related to the mean of log sec χ along the path, where χ is the solar zenith angle. Different flares, however, produce different curves of Δh versus the mean of log sec χ. These results are discussed in terms of a layer produced below the normal height of reflection, and the energy and intensity of the x rays that produced the new layer are estimated. (auth)

37909 ALTERING THE ELECTRON DENSITY IN THE D REGION: A NEW TOOL FOR IONOSPHERIC D-LAYER RESEARCH. Paul Molmud (Space Technology Labs., Redondo Beach, Calif.). J. Geophys. Res., 68: 5443-51 (Oct. 1, 1963).

The attachment coefficient for electrons attaching to molecular oxygen has non-negligible electron energy dependence. High-powered ground-based radio transmitters can be used to heat the electrons in the D region, change their attachment coefficients, and thus change their density. Such density changes can be effected only below about 80 km because of the photodetachment process. To illustrate these

effects, hypothetical experiments that use powerful transmitters are described. The resulting data are analyzed to yield values for most of the fundamental parameters characterizing the D region. A method is suggested by which rapid changes in electron density distribution in the D region can be followed. (auth)

37910 IONIZATION OF THE ATMOSPHERE DUE TO BETA PARTICLES EMITTED BY FISSION PRODUCTS. S. Kownacki (Lockheed Missiles and Space Co., Sunnyvale, Calif.). J. Geophys. Res., 68: 5461-71(Oct. 1, 1963).

Persistent ionization of air at moderate heights, just below the E layer, after high-altitude nuclear detonations is predominantly due to radiations accompanying radioactive decay of fission products. The most important are β particles, which are restricted in their movements by the earth's magnetic field and thus create ionized clouds of high density in localized regions. A method of investigating this phenomenon is discussed, in which the geometry of the problem, the rate of loss of energy by a particle moving through gas of varying density, and the composite energy spectrum of radiation from fragments of an average fission of uranium-235 are considered jointly. Several simplifying assumptions are made; in particular, elastic scattering of the β particles by air is neglected. This simplification appears to be justified in the present circumstances. A technique is developed in which the ion-pair production rate is first computed as a function of the mass of gas traversed in the direction of a magnetic field line, and is then converted to any arbitrary situation described in terms of the actual height of the debris deposition and an arbitrary magnetic dip angle. Results of computations are normalized to one fission or one particle, and the method of conversion from one normalization to the other is given for any time after the detonation. (auth)

37911 FAST-NEUTRON FLUX IN THE ATMOSPHERE. R. B. Mendell and S. A. Korff (New York Univ., New York). J. Geophys. Res., 68: 5487-95(Oct. 1, 1963).

A fast-neutron detector was carried by balloon up to 27.4 km. The detector consisted of an inner liquid scintillator, employing pulse-shape discrimination, and a thin 4π phosphor shield for rejection of charged particles. Both scintillators were viewed by a single photomultiplier. The counting rates produced by neutrons in two energy intervals between 1 and 10 Mev were recorded. The best fit to a power law spectrum was $N(E)\,dE = 2.6E^{-1.16\pm0.2}\exp(-0.0069x)\,dE$ neutrons/cm^2 sec Mev in the equilibrium region. The counting rate rose to a broad maximum at about 75 g/cm^2, where the total flux of neutrons between 1 and 10 Mev was 1.9 neutrons/cm^2 sec. The flux at floating altitude was 1.4 neutrons/cm^2 sec. The results are compared with those of Newkirk and of Hess. (auth)

37912 STUDIES OF PARTICLES FOR EXTRATERRESTRIAL ORIGIN. 1. CHEMICAL ANALYSES OF 118 PARTICLES. Frances W. Wright (Smithsonian Astrophysical Observatory, Cambridge, Mass.), Paul W. Hodge, and Chester C. Langway, Jr. J. Geophys. Res., 68: 5575-87(Oct. 1, 1963).

Dust particles of probable or known extraterrestrial origin were gathered, for the purpose of comparison, from a number of sources, including the stratosphere, 750-year-old Greenland ice, 55-year-old antarctic ice, the antarctic atmosphere, a New Mexico mountaintop, glacial ice caves, and the place of fall of the Siberian Sikhote-Alin meteorite shower. Out of the wide variety of types of particles in these samples, 118 representative particles were subjected to detailed chemical analysis by the electron-beam microanalyzer technique. The Fe/Ni ratios of 5 particles point undoubtedly to their meteoritic origin. From their high Fe/Si ratio some 35 others are thought to be extraterrestrial. A few objects are identified from their compositions as being of obvious terrestrial origin. The cosmic influx of dust on the earth's surface is computed to be more than 10^5 tons per year. (auth)

37913 CORRELATION OF NEUTRON MONITOR PRESSURE COEFFICIENT AND THE SOLAR CYCLE. J. L. Kamphouse (New York Univ., New York). J. Geophys. Res., 68: 5608-10(Oct. 1, 1963).

The possibility that the pressure coefficient of a standard neutron monitor might vary in accordance with the sunspot cycle was investigated. The correlation between sunspot numbers and attenuation length of the nucleonic component was presented. It is noted that close to solar maximum the pressure coefficient is smallest, and near solar minimum it is largest. It is proposed that the higher energy spectra at solar maximum may indicate that some of the low-energy particles are being kept away from the earth by the greater amount of solar plasma at this time. This leads to the view that at sunspot maximum the sun is more active in emitting a plasma that modifies the radiation arriving from outside the solar system with a phase lagging the sunspot cycle by about a year. (C.E.S.)

37914 THE INTERPLANETARY MAGNETIC FIELD. V. A. Bailey (Univ. of Sydney). Nature, 199: 1029-31 (Sept. 14, 1963).

A new analysis of magnetic and concurrent plasma data collected from the space probes Pioneer 5, Explorer 10, and Mariner 2 yields a new model of the interplanetary magnetic field. It is hypothesized that the observed interplanetary field F_I is due to motion of the magnetometer relative to a negatively charged rotating sun from which magnetic lines of force are drawn out into space by a flow of plasma clouds and from which solar disturbances are propagated as generalized magneto-ionic waves. Application of the hypothesis is made to facts gathered from the space probes. It is proposed that future space probes carry devices that can determine the concentration of the protons and electrons separately, or else the concentration of the protons and of the excess charges per unit volume of plasma, and a device for measuring ambient electrostatic fields ranging from 10 to 1000 v/cm. (H.M.G.)

37915 CHANGE IN ROTATION PERIOD OF JUPITER'S DECAMETER RADIO SOURCES. James N. Douglas and Harlan J. Smith (Yale Univ., New Haven). Nature, 199: 1080-1(Sept. 14, 1963).

Data are presented that tend to refute the hypothesis that Jupiter's decameter radio sources have a constant period. Preliminary analysis of 22.2-Mc/sec observations made at Bethany Observing Station of the Yale Observatory in 1962 and 1963 indicates that the rotation period of the radio sources has lengthened approximately 0.8 sec. Review of the number of occurrences of Jupiter activity for each 5° interval of System III (1957.0) longitude of central meridian for the years 1961, 1962, and 1963 (to July 7) reveals a progressive drift in longitude of the major peak of about 10° per year. This corresponds to the 0.8 sec lengthening of the period. On a Whittaker periodogram plot of the same material for a variety of assumed periods, the 0.8 sec lengthening is clear and not explainable by statistical fluctuation. Observations of the red spot motion are discussed in view of the decameter result reported herein. (H.M.G.)

37916 SOLAR OBSERVATIONS OBTAINED FROM VERTICAL SOUNDING. Herbert Friedman (Naval Research Lab., Washington, D. C.). Rept. Progr. Phys., 25: 163-217(1962).

The equipment and procedures used to examine the sun and its activity by observing the full spectrum of solar ultraviolet and x-ray emissions are reviewed along with the experimental results and their interpretation. Balloon, rocket, and satellite observations are all included. 76 references. (D.C.W.)

Cosmic Radiation

37917 (TID-17346) A NOTE ON THE SEPARATION OF WORLD WIDE CHANGES OF ISOTROPIC INTENSITY FROM THE DAILY VARIATION OF COSMIC RAYS. U. R. Rao (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Nov. 28, 1962. Contract AT(30-1)-2098. 7p.

Sakidor's method for correcting the observed daily variation of cosmic ray intensity for distortion due to world-wide changes of isotropic cosmic ray intensity is shown to be subject to large errors. (D.C.W.)

37918 LATITUDE SURVEY OF COSMIC-RAY INTENSITY BY EXPLORER 7, OCTOBER 1959 TO FEBRUARY 1961. W. C. Lin, D. Venkatesan, and J. A. Van Allen (Iowa State Univ., Iowa City). J. Geophys. Res., 68: 4885-96(Sept. 1, 1963).

A shielded Geiger tube in the Explorer 7 satellite was used in a comprehensive geographic survey of the intensity of charged particles in the latitude range ± 50.5°, in the altitude range 550 to 1100 km, and over the 16-month period October 13, 1959, to February 17, 1961. It was found possible to identify and eliminate contributions by geomagnetically trapped particles and thus to obtain the sum of the absolute intensities of primary galactic cosmic rays and of their charged-particle secondaries (albedo) produced in the atmosphere. Specific results are as follows: (1) The counting-rate data from both northern and southern hemispheres and over a considerable range of longitudes are represented in a simple and coherent manner as a function of a single parameter, the McIlwain magnetic shell parameter L. (2) The counting rate increases monotonically with increasing L and has an accurately constant value for $L > 2.9$. (3) The high-latitude knee of the counting rate versus L curve occurs at $L = 2.6$ (corresponding to the invariant latitude 52°) and is indiscernibly different in the northern and southern hemispheres. (4) The absolute omnidirectional intensity is 0.56 $(cm^2\ sec)^{-1}$ at the equator and 2.0 $(cm^2\ sec)^{-1}$ at high latitudes, the ratio being 3.6. (5) At high latitudes the intensity increases by the factor 1.046 ± 0.045 during the 16-month period. (6) In terms of the Quenby-Wenk vertical cutoff rigidity R, in billion volts, the total omnidirectional intensity $J_0(>R) = 4.3R^{-0.83\pm0.02}$ $(cm^2\ sec)^{-1}$ for $3 < R < 12$ bv and $J_0 = 2.0$ $(cm^2\ sec)^{-1}$ for $R < 1.7$ bv. (auth)

37919 RADIOACTIVE NUCLIDES PRODUCED BY COSMIC RAYS IN SPUTNIK 4. Julian P. Shedlovsky and James H. Kaye (Carnegie Inst. of Tech., Pittsburgh). J. Geophys. Res., 68: 5069-78(Sept. 1, 1963). (TID-17694)

The Sputnik 4 satellite re-entered the earth's atmosphere on September 5, 1962, after 843 days in orbit. From a portion of the recovered iron mass, a number of radioactive nuclides were measured after wet chemical separations. These activities are compared with those found in the Aroos iron meteorite. The ratio of saturation activities Sputnik 4/Aroos increases, with increasing A, from 0.20 for Ar^{37} to 0.68 for Fe^{55}. It appears that this increase is caused by low-energy solar-flare particles. The $Co^{56+57+58}$ ratio is 0.098, which reflects the different nickel contents of the two objects. The sample contains 40 dpm/kg Co^{60}, which is of noncosmogenic origin. (auth)

37920 FIRST-ORDER EFFECT OF MAGNETIC MOMENT NONCONSERVATION FOR GEOMAGNETICALLY TRAPPED PARTICLES. Robert W. Harris (Sandia Lab., Albuquerque, N. Mex.). J. Geophys. Res., 68: 5125-33 (Sept. 15, 1963). (TID-18698; SCDC-3230)

It is shown that for particles trapped in the geomagnetic field the first-order effect of nonconservation of magnetic moment is to raise the mirror points by an amount depending on the position of the unperturbed mirror point. It is shown that the net change in the magnetic moment over a complete north-south mirror oscillation is zero, and that the effect is therefore a static deformation of the orbit (i.e., there is not a progressive raising of the mirror points). An expression is derived for the angular derivative of the magnetic moment, and from this an expression is obtained for the increase in mirroring altitude. It is seen that the effect is most significant for high-energy protons trapped on high magnetic shells and is essentially negligible for electrons. (auth)

37921 ON THE DEPOSITION OF COSMIC-RAY-PRODUCED BERYLLIUM 7. J. F. Bleichrodt and E. R. van Abkoude (National Defence Research Council T.N.O., Rijswijk, Z. H., Netherlands). J. Geophys. Res., 68: 5283-8(Sept. 15, 1963).

The observed annual deposition of cosmic-ray-produced Be^7 in the Netherlands exceeds the amount expected from tropospheric production. The difference agrees with an estimated contribution of natural Be^7 originating from the stratosphere. (auth)

37922 TRITIUM, ARGON 37, AND MANGANESE 54 RADIOACTIVITIES IN A FRAGMENT OF SPUTNIK 4. J. DeFelice, E. L. Fireman, and D. Tilles (Smithsonian Astrophysical Observatory, Cambridge, Mass.). J. Geophys. Res., 68: 5289-96(Sept. 15, 1963).

Tritium, Ar^{37}, and Mn^{54} radioactivities were measured in samples from a steel fragment of Sputnik 4. The tritium activity was low compared with the amount expected to be produced by cosmic rays. Some metallurgical evidence suggests the possibility that the lowest tritium content was in the sample that may have experienced the most heating. The amount of manganese 54 radioactivity was approximately 40% of the value obtained in Aroos by others, whereas the amount of Ar^{37} was about 20% of that measured in Aroos and about 30% of that estimated from the Ar^{39} measurements in Aroos, Norfork, Pitts, and Treysa, together with the ratio of production cross sections. (auth)

37923 THE ANOMALOUS ENTRY OF LOW-RIGIDITY SOLAR COSMIC RAYS INTO THE GEOMAGNETIC FIELD. S.-I. Akasofu (Univ. of Alaska, College), W. C. Lin, and J. A. Van Allen. J. Geophys. Res., 68: 5327-38(Oct. 1, 1963).

It is shown that the observed arrival of low-rigidity solar cosmic rays at latitudes much below those predicted by the Störmer theory for the dipole field of the earth cannot be explained, either by a physically plausible ring current or by any experimentally established limitation of the radial extent of the magnetosphere, if either perturbation is acting alone. It is then demonstrated by an approximate theoretical treatment that the observed reductions of geomagnetic cutoffs can be explained plausibly and quantitatively as due

to the combined effects of these two perturbations. The study was limited to the noon meridian, but it is believed that the essential elements of the approximate theory will survive in a more complete treatment of the problem. (auth)

37924 ENERGY SPECTRUM OF PRIMARY COSMIC RAYS. Saburo Miyake (Osaka City Univ.). J. Phys. Soc. Japan, 18: 1226-7(Aug. 1963).

From geomagnetic data in the region of 1 to 20 Bev and emulsion data at about 10^{12} ev, the primary energy spectrum was estimated. The value was considerably low compared with older estimates. The method of estimation is given. (R.E.U.)

37925 GAMMA RAYS AND MAGNETIC BREMSSTRAHLUNG X RAYS OF GALACTIC AND METAGALACTIC ORIGIN. V. L. Ginzburg and S. I. Sirovatskii (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 353-63(Aug. 1963). (In Russian)

The intensity of γ rays due to the decay of π^0 mesons produced in nuclear collisions of cosmic rays in interstellar and intergalactic space is computed. The intensity of x rays due to magnetic deceleration of $\pi^{\pm}$ meson decay electrons (or positrons) is calculated for the same conditions. The γ and x ray intensities thus obtained are smaller than the cosmic γ and x ray intensities recorded in several investigations by several orders of magnitude. (auth)

37926 ANTIMATTER IN COSMIC RADIATION. N. L. Grigorov, D. A. Zhuravlev, and M. A. Kondrat'eva, I. D. Rapoport, and I. A. Savenko (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 394(Aug. 1963). (In Russian)

Investigations of 487 stacks of 10 × 10 cm 400μ emulsion exposed at 300 km showed that none of the 1079 ordinary nuclei and 748 stars could be considered the result of stopped antinucleus annihilation. Therefore it was concluded that the number of antinuclei with Z > 2 does not exceed 0.1% in the primary cosmic emission. (R.V.J.)

37927 AN ANALYSIS OF THE ALASKA NEUTRON MONITOR DATA AND OTHER DATA: THE COSMIC RAY INCREASES OF 1960. Wallace Arthur. Thesis, New York, New York Univ., 1962. 102p.

The four large cosmic ray increases of 1960 were studied using data from the College, Alaska neutron monitor and other data. The rigidity spectrum of solar proton on Nov. 12 and 13 from 2023 to 0500 UT was calculated to be proportional to rigidity to the -5.9 ± 0.5 power. The rigidity spectrum on Nov. 15 from 0931 to 1307 UT was calculated to be rigidity to the -6.1 ± 0.5 power. The anomalous increase of Nov. 12 was accounted for by the arrival of successive plasma clouds emitted before the generation of solar protons of cosmic-ray energy. The possibility of the storage of the solar protons inside these plasma clouds is discussed. The characteristics of the increases of May 4, and Nov. 12, 15, and 20, 1960 were compared with the McCracken-Palmeira model of cosmic ray increases. The phase after maximum intensity was attained is discussed in terms of an exponential decrease with time. The maximum intensity inside a plasma cloud during Nov. 12 was extrapolated using an exponential. This extrapolation was compared with other methods. (Dissertation Abstr.)

37928 AIRBORNE SURVEY OF THE NUCLEONIC COMPONENT OF COSMIC RAYS AND THE MAGNETIC FIELD OF THE EARTH. Som Prakash Agarwal. Thesis, Philadelphia, Temple Univ., 1962. 155p.

The spatial distribution of the intensity of primary cosmic radiation, as detected through their nucleonic component progeny observed deep within the earth's atmosphere, was measured, covering extensive portions around the globe, with an airborne neutron monitor, installed aboard a Super Constellation aircraft of the U. S. Navy Hydrographic Office. The measurements have extended over a period November, 1958 to October 1960. The data obtained during ascents and descents, as well as periods of level flight at different altitudes, above a fixed station, provided determinations of the atmospheric absorption mean free path at different latitudes. Absorption curves were obtained from the counting-rate versus pressure-altitude measurements, recorded at 22 different locations from the Arctic to the Antarctic. The results indicated that the absorption coefficient of the nucleonic component in the lower atmosphere (atmospheric depth > 500 g/cm^2) is a function of the primary threshold rigidity over the range 2.5 to 15 Bv. The change from equator to high latitude amounts to approximately 10%. For high altitude stations, having threshold rigidity less than 2.5 Bv, the absorption mean free path length tends to become constant. The weighted mean of all the independent determinations at 7 high latitude stations (P_c < 2.5 Bv) yielded a value for the attenuation length, $L = 135.2 \pm 0.8$ gm/cm^2. Repeated measurements of the absorption mean free path made at Washington (D.C.), Kodiak (Aleutian Is.), and Honolulu (Hawaiian Is.), showed that within experimental and statistical uncertainties, the absorption mean free path length, at a given location, remained essentially constant, during the period of the measurements. The analysis of the measurements obtained during the aircraft cruising altitude provided a comparison among geomagnetic threshold rigidity calculations based upon various approximations to the terrestrial magnetic field. A plot of the intensity of the nucleonic component versus threshold rigidity computed in accordance with the theoretical calculations of Quenby and Wenk, who took into account the effects of the dipole and non-dipole parts of the earth's internal field, as well as the penumbral correction at the low and intermediate latitudes, revealed that, except for measurements over one region in the North Atlantic, all the data fall within a narrow band. The contrast with previous rigidity cut-off assignments, based either on the centered-dipole theory, or on dipole plus non-dipole formulation of Quenby and Webber, is striking. A contour map of equal intensities (isocosms) was obtained for the entire globe. The isocosmic map shows that the general variations of the lines of equal cosmic-ray intensity coincide with the topography of magnetic rigidity. It was concluded that the Quenby-Wenk representation is essentially correct. The geomagnetic field effective on cosmic particles is due to the geomagnetic field which consists of both the dipole and non-dipole parts of the internal field. Fields of external origin do not significantly influence the trajectories of cosmic-ray primary charged particles. The effect of the main cone at intermediate latitudes is a very important factor in determining the threshold magnetic rigidities. In the region, where significant discrepancy is noted between theory and experiment, the measurements provide an empirical correction and suggest a revision of the interpolation procedure which was used by Quenby and Wenk in their work. Determinations of the location of the cosmic-ray equator were also made at six points. The results indicated that a very good agreement is achieved with the theoretical cosmic-ray equator computed using all the moments through 2^6 pole. A plot of the minimum intensity as a function of longitude showed that at the cosmic-ray equa-

tor, the magnitude of the longitude effect is substantial. The peak to peak amplitude is approximately 25%. A comparison of the nucleonic intensity measurements obtained in the North and South polar regions, indicated that the primary flux in the two regions is the same within about 0.5%, the limit being imposed due to the statistical and experimental uncertainties. This result implies that there is no asymmetry in the average flux reaching the earth in the polar regions and that at large distances from the earth cosmic-rays are distributed isotropically. (Dissertation Abstr.)

Criticality Studies

37929 ON THE POSSIBILITY OF INCREASING THE INITIAL TOTAL CONVERSION FACTOR OF CRITICAL NATURAL URANIUM–HEAVY WATER ARRANGEMENTS. G. Locke. Atomkernenergie, 8: 277-96(July-Aug. 1963). (In German)

The integral equation for the thermal neutron flux of a critical natural uranium-heavy water arrangement with variable fuel density and infinitely extended reflector was deduced from the differential equations of the two-group-theory. In order to arrive at fuel distributions which get along with as little uranium as possible at a certain initial conversion, the condition for the minimization of the critical fuel mass was established. The solution resulting therefrom in the case of absent breeding material in the reactor core was used as an approximation solution for the problem, and the uranium requirements of such arrangements were calculated in dependence of the initial conversion factor. Fuel savings of maximally 20%, as compared to the usual critical arrangements with constant fuel density, resulted. The systematic calculation of two-region-arrangements led to similar results if the fuel distribution in these arrangements were qualitatively similar to that of the constant flux reactor. (auth)

Elementary Particles and Radiations

37930 (CERN-63-27) INTERACTIONS OF POSITIVE PIONS WITH PROTONS NEAR THRESHOLD FOR SINGLE PION PRODUCTION. V. E. Barnes (Cambridge Univ., England. Cavendish Lab.); I. Derado (European Organization for Nuclear Research, Geneva); R. Carrara, et al. (Padua. Universita. Istituto di Fisica; and Italy. Istituto Nazionale di Fisica Nucleare, Padua). July 22, 1963. 15p.

The π^+-p interaction in the 300 Mev kinetic energy region was studied in a hydrogen bubble chamber. Three types of events were considered: elastic scattering, single pion production and single photon production. In the elastic scattering the phase shifts of the Fermi I solution are substantially compatible with previous results. Cross sections are determined for the in elastic processes and, although statistics are very low, the results are compared with calculations based on the peripheral and the isobaric models. (auth)

37931 (JINR-P-1282) VOZMOZHNOE POSTROENIE SISTEMY IZOBARNYKH SOSTOYANII I SKHEM IKH PEREKHODOV. (Possible System of Isobar States and Schemes of Their Transitions). V. F. Vishnevskii, Yuan-tsai Tu, V. N. Moroz, A. V. Nikitin, Yu. A. Troyan, Shao-chuing Chiang, Weng-yu Chang, B. A. Shahbazyan, and Wu-Kuang Yen (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 11p.

Nucleon and hyperon isobars considered as "excited states" in terms of their effective masses, isotope spins, spins, parities, etc., are classified into three groups according to (S = 0, Y = +1), (S = –1, Y = 0), and (S = –2, Y = –1), respectively. Possible transitions between these "excited states" are suggested, several of them being already found experimentally. Within a single group the transitions are characterized by, as the 'quantum' of emission, a π-meson, or a ρ, an η or an ω, while for the inter-groups the transitions are by a K-meson and K*. The ground states of the last two groups will have transitions by the weak interaction decay to the ground state of the nucleon isobars, i.e., the ordinary nucleons. Concrete isobar transitions from such schemes have been given a satisfactory explanation, when applied, together with the kinematic method, to the analysis of the momentum groups of Λ°-hyperons as found experimentally in the 7-8 Bev π^--p interaction. (auth)

37932 (JINR-P-1284) OB ODNOM METODE DLYA CHISLENNOGO RESHENIYA URAVNENII TIPA URAVNENII RASSEYANIYA LOU. (A Method of Numerical Solution of Equations of the Low Type). P. Byrnev, R. Denchev, and Kim Tse Peng (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 14p.

A method of numerical solution of equations of the Low type is suggested. Two examples are considered in detail: the model equation and the equations of π-π scattering. (auth)

37933 (JINR-P-1297) O VOZMOZHNOI SKHEME OBRAZOVANIYA Λ-GIPERONOV CHEREZ IZOBARY V π^-p-VZAIMODEISTVIYAKH PRI ENERGIYZHK 7 TO 8 Bev. (On the Possible Scheme of Production of Λ-Hyperons Via Isobars in π^--p-Interaction at 7 to 8 Bev Energy). V. F. Vishnevskii, Yuan-ts'ai Tu, V. I. Morozov, A. V. Nikitin, Yu. A. Troyan, Shao-chuing Chiang, Weng-yu Chang, B. A. Shakhbaziyan, and Wu-kuang Yen (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 18p.

The hyperon (Λ) groups observed are satisfactorily explained by assuming that the hyperons come out as the decay products (via strong interaction) of the isobars (including Y* resonant particles- hyperon isobars), which are formed first in the π^--p interaction. (auth)

37934 (JINR-P-1309) IZMERENIE RAZNOSTI MASS ZARYAZHENNYKH I NEITRAL'NYKH PIONOV. (Measurement of Mass Difference of Charged and Neutral Pions). V. I. Petrukhin and Yu. D. Prokoshkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 11p.

The angular correlation of γ-quanta from the decay of neutral pions produced in the capture of negative pions by protons was measured. The magnitude of the pion mass difference was found to be (4.60 ± 0.02) Mev/c^2. The measurements were made by a method that is not affected by possible systematic inaccuracies due to the determination of the angular resolution and geometric corrections. (auth)

37935 (JINR-P-1312) FAZOVYE SDVIGI p-p RASSEYANIYA PRI 435 Mev. (p-p Phase Shifts at 435 Mev). L. S. Azhgieri (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 8p.

A phase shift set was found which describes satisfactorily experimental data on p-p scattering for energies about 435 Mev and which fits well with a previously-obtained smooth energy dependence of phase shifts. (auth)

37936 (JINR-P-1321) GEOMETRICHESKAYA OPTIKA ELEMENTARNYKH CHASTITS. (Geometric Optics of Elementary Particles). D. I. Blokhintsev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 6p.

It is shown that the nonlocal potential deduced from quantum field theory may be replaced by a local, complex refraction index for large wave numbers. (auth)

37937 (JINR-P-1332) OTSENKA OTNOSITEL'NOI VEROYATNOSTI RASPADA $K_2^0 \to 3\pi^0$. (An Estimation of the Relative Probability of the $K_2^0 \to 3\pi^0$ Decay). M. Anikina, M. Zhuravleva, D. Kotlyarevskii, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 11p.

The relative probability of the $K_2^0 \to 3\pi^0$ decay with respect to all the modes of the K_2^0 decay into charged particles was estimated experimentally to be (0.24 ± 0.08). (auth)

37938 (JINR-P-1353) ASIMPTOTICHESKIO SOOTNOSHENIYA MEZHDU SECHENIYAMI V LOKAL'NOI TEORII POLYA. (Asymptotic Relations between Cross Sections in Local Field Theory). A. A. Logunov, Nguyen-Van-Hieu, I. T. Todorov, and O. A. Khrustalev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 13p.

A number of asymptotic relations between the differential and total scattering cross section at high energy was obtained on the basis of the general postulates of the local relativistic quantum field theory. All the conclusions are based on the assumption that the cross sections at high energy are not oscillating and on Phragmen and Lindelof's theorem in the theory of analytical functions. (auth)

37939 (UCRL-10600) HIGH-ENERGY CROSS SECTIONS AND THE CHEW-FRAUTSCHI PARTICLE. Alberto Pignotti (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 17, 1962. Contract W-7405-eng-48. 13p.

It is shown that the recently discovered π-π resonance at 1250 Mev can not be the particle predicted by Chew and Frautschi if some reasonable hypotheses on Regge poles are verified and if the experimental data on high-energy differential cross sections are considered. It is also suggested that the predicted particle may have an energy less than or near the meson (ρ) energy. (auth)

37940 (NP-tr-1056) ANTI-MATTER. R. Hagedorn. Translated by G. G. Kinnane (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Physik. Bl., 18: 255-63(1962). 20p.

The theoretical discovery of anti-particles is outlined, and their properties and behavior are briefly discussed. The experimental discovery (particularly the problems therein) of $\bar{p}$ at Berkeley is reviewed as well as experiments performed on $\bar{p}$-p scattering and annihilation, and the theory devised to explain the experimental results. Use of annihilation to study meson (π) interaction is also outlined, and the existence of antimatter in the cosmos is shown to be possible. (D.C.W.)

37941 INTERACTION OF FAST ELECTRONS WITH FREE AND BOUND ATOMIC ELECTRONS. M. Croitoru. Acad. Rep. Populare Romîne, Studii Cercetări Fiz., 14: 177-99(1963). (In Rumanian)

As a result of its interaction with matter, a beam of collimated monoenergetic electrons becomes polyenergetic and divergent. The interaction may involve electron–electron processes of the beam electrons with the orbital electrons, or nuclear scattering by the Coulomb field of the nucleus. The principles of the fast electrons interactions with free and bound atomic electrons are reviewed, including the methods used for determining the scattering cross section and the slowing-down power; in addition, the excitation potential studies and the experimental techniques were examined. It was concluded that in order to obtain experimental values of comparable magnitude with the theoretical predictions, the energy distribution of the incident beam should not exceed 1% of the incident energy, otherwise the distribution of the losses must be taken into account. The radiations must be well collimated both before and after leaving the target foil, in order to avoid capture of the electrons scattered under a large angle which thus pass through a path longer than the thickness of the foil. (32 references) (TTT)

37942 NEW RESULTS IN ELEMENTARY PARTICLE PHYSICS. R. Hagedorn (CERN, Geneva). Acta Phys. Austriaca, 16: 217-33(1963). (In German)

The experimental and theoretical results obtained in 1961-62 on strong and weak interactions are summarized briefly. The most important conclusions in the area of weak interactions are the probability that the rules $\Delta S = \Delta Q$ and $|\Delta T| = {}^1/_2$ are not valid and that there are two types of neutrinos. In the area of strong interactions the scattering behavior was studied. The new resonances and their properties are tabulated and discussed. (J.S.R.)

37943 SUM RULES FOR NUCLEON FORM FACTORS. A. P. Balachandran and H. Pietschmann (Universität, Vienna). Acta Phys. Austriaca, 16: 362-5(1963). (In German)

Sum rules for the approximation of the one-nucleon intermediate states are derived and analyzed for the case $\underline{s} = 0$. The contribution of free nucleon states to the sum rules is determined. (J.S.R.)

37944 EXCHANGE OF TWO PHOTONS IN ELECTRON-PROTON SCATTERING. Dieter Flamm and Wolfgang Kummer. Acta Phys. Austriaca, 16: 366-9(1963). (In German)

Dispersion relations were used to study the effects of resonances in the $p\bar{p}$ channel of electron-proton scattering. Only the proton-antiproton channel was considered in the simple dispersion relation $B_1 = 1/\pi \int [dt' \; B_{1,A}(\bar{s},t')/(t'-t)]$, where $t = (p_1 - \bar{p}_1)^2$ is the center of mass energy in the proton-antiproton pair annihilation channel and $\bar{s} = (p_1 - q_2)^2$ is the pulse transfer. The effect of the resonances with the lowest angular momentum on the Compton amplitude is determined. In order to obtain the effect of the two-photon corrector, a 2^+ tensor resonance must be present. A primitive model in which the 2^+ resonance was directly exchanged between the electron and proton was used to estimate order of magnitudes. It was found that for a 10% contribution of the correction term a coupling of the plausible order of magnitude of one is necessary for $g_e g_{N_1}$ and $g_e g_{N_2}$. (J.S.R.)

37945 BREMSSTRAHLUNG IN HIGH-ENERGY ELECTRON-ELECTRON SCATTERING WITH CONSIDERATION OF THE STRUCTURE OF THE COLLIDING PARTICLE. K. Logar and P. Urban (Universität, Graz). Acta Phys. Austriaca, 16: 370-3(1963). (In German)

The Weizsacker-Williams method was used to calculate the bremsstrahlung in high-energy electron-electron scattering. It was assumed that the velocity of the particle approached the speed of light and that it was traveling in a straight line. The principles of the method were described, and the inaccuracies inherent in the replacement of an electron field with a radiation field were given. The structure of the electron was expressed by the modification of the Coulomb field. The formula for the effective cross section of the bremsstrahlung was derived and includes the

bremsstrahlung for a point particle, the structure of the particle at rest, and the structure of the incident fast electron. The structure terms reduce the effective cross section. The method is applicable to electron-proton scattering. (J.S.R.)

37946 SMALL ANGLE DELBRÜCK SCATTERING. Fritz Ehlotzky (Universität, Innsbruck, Austria). Acta Phys. Austriaca, 16: 374-8(1963). (In German)

A comparison of the Bethe-Rohrlich and the Jost-Luttinger-Slotnik formulas for the total cross section for pair production in the electric field of an atomic nucleus gave a new expression for the γ function of the Bethe-Rohrlich expression for the imaginary part of the Delbrück scattering amplitude. The new γ function improved the agreement of theory with experimental data. (J.S.R.)

37947 RECENT THEORETICAL CONSIDERATIONS ON ULTRA HIGH ENERGY NUCLEAR COLLISIONS. APPLICATIONS OF THE REGGE POLE THEORY AND A RELATED PHENOMENOLOGICAL APPROACH. Ziro Koba (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Fortschr. Physik, 11: 118-62(1963). (In German)

Recent theoretical works on ultra-high-energy nuclear collisions (cosmic ray jets) are surveyed. In view of the recent achievements of the relativistic Regge pole theory in the accelerator region and its further potentiality, the review is mainly concerned with applications of this theory to ultra-high-energy nuclear interactions, including, however, a closely related phenomenological approach, too. The topics covered are: behavior of cross sections at ultra high energy; a necessary condition, tentatively called "shadow criterion," imposed on any model of the multiple particle production, and two models which satisfy this requirement; extension of the Regge pole theory to the production processes; and general phenomenological considerations on the chain model. (auth)

37948 COMPLEX SINGULARITIES IN PRODUCTION AMPLITUDES. D. Bessis and F. Pham (Centre d'Etudes Nucléaires Saclay, France and Service de Physique Mathématique, Gif-sur-Yvette, France). J. Math. Phys. (N. Y.), 4: 1253-7(Oct. 1963).

It is shown for a simple model of production that Watson's scheme for final-state interaction may be good even though the amplitude has complex singularities. The method used consists of continuing analytically partial-wave dispersion relations. Stress is put upon the necessity of correctly choosing the cuts starting at the complex singularities. The safest choice in this approach is to take the cut along the line on which the series of partial waves diverges. A simple geometrical recipe is given to see the evolution of this line, the appearance of an anomalous threshold, and a complex singularity. (auth)

37949 REGGE POLES IN HIGH-ENERGY POTENTIAL SCATTERING. S. Tani (New York Univ., New York). J. Math. Phys. (N. Y.), 4: 1258-62(Oct. 1963).

High-energy potential scattering based on the Schrödinger equation was investigated using Regge poles. When the Watson-Sommerfeld integral is directly applied in the left half-plane, it is not useful at all in order to derive the scattering amplitude but gives a condition which governs the behavior of Regge poles. They are distributed with residues such that their contributions cancel against each other in the nonforward direction, provided that the integral at infinity is ignored. When Mandelstam's technique is used, the Legendre function of the first kind and the secant in the original W-S integral are replaced by the Legendre function of the second kind and the cosecant, respectively. This allows summation over partial waves more easily than with the conventional series. In high-energy potential scattering one cannot single out an individual Regge pole. The same conclusion follows when Khuri's representation is used. (auth)

37950 INVARIANT OPERATORS OF THE UNITARY UNIMODULAR GROUP IN n DIMENSIONS. Abraham Klein (Univ. of Pennsylvania, Philadelphia). J. Math. Phys. (N. Y.), 4: 1283-4(Oct. 1963).

An elementary derivation is given of Biedenharn's construction of a complete set of independent invariants for the group SU(n). The basic tool is the mapping of the adjoint representation onto the linear space of generators in the defining representation. The trace of any algebraic function of the matrix thus associated is seen to constitute an invariant of the adjoint representation and yields by substitution an invariant operator. The independent invariants are recognized by their isomorphy to the invariant forms under the permutation group. (auth)

37951 NEW SMALL-ANGLE X-RAY SCATTERING CALCULATION. W. S. Rothwell (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Math. Phys. (N. Y.), 4: 1334-7(Oct. 1963).

A method due to Hardy for evaluating finite integrals is used to obtain the structure factors for several rotationally symmetric shapes. The factor for particles formed by joining paraboloids of revolution is shown to be proportional to a second-order Lommel function of two variables. (auth)

37952 THE EXISTENCE OF A BOUND HYPERON-NUCLEON SYSTEM WITH ISOBARS. Van Royen. Mededel. Koninkl. Vlaam. Acad. Westenschap., Belg., Kl. Wetenschap., 24: No. 7, 3-9(1962). (In Flemish)

From recent analysis of the hyperon-nucleon potential it appears that the hyperon-nucleon system is not bound. If one makes the assumption that the potential between the newly discovered hyperon resonance and a nucleon is the same form, then the increased reduced mass of this system makes binding likely. (auth)

37953 ELECTRIC POLARIZATION OF THE DEUTERON BY A POINT CHARGE. Richard J. Drachman (Brandeis Univ., Waltham, Mass.). Phys. Rev., 132: 374-7(Oct. 1, 1963).

The perturbation of the ground-state energy of the deuteron due to a fixed point charge at any distance is calculated, using the method of Dalgarno and Lewis and a simple ground-state wave function. Deviations from the uniform field results are evaluated for various distances and amount to about 5% for regions of interest. (auth)

37954 SOME IMPLICATIONS OF HIGHER SYMMETRIES. H. Ruegg and S. B. Treiman (Princeton Univ., N. J.). Phys. Rev., 132: 384-7(Oct. 1, 1963).

Spin correlation effects in baryon-baryon scattering are discussed as tests for the existence of higher symmetries in strong interaction physics. It is shown that the detection of certain characteristic correlations could serve to rule out at once whole classes of potential higher symmetry candidates. Other sorts of testable effects, which bear on particular models of higher symmetry under current discussion, are also briefly described. (auth)

37955 DECAY OF THE π MESON AND GOLDBERGER-TREIMAN RELATION. Masakuni Ida (Univ. of Illinois, Urbana). Phys. Rev., 132: 401-6(Oct. 1, 1963).

An extension of Goldberger and Treiman's approach to charged pion decay is attempted. Derivation of a generalized Goldberger-Treiman relation is studied without recourse to the nucleon-antinucleon pair approximation. A certain type of dispersion relation is presupposed for the annihilation amplitudes of intermediate states into a lepton pair, which contribute to the imaginary part of the decay amplitude. Also discussed is the determination, in principle, of the weak-coupling constants responsible for the decay. (auth)

37956 ELECTROMAGNETIC INDUCTION OF NEUTRAL LEPTON CURRENTS. Mirza A. Baqi Bég (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 132: 426-31 (Oct. 1, 1963).

The induction of neutral lepton currents in the weak interaction Lagrangian is considered through the mediation of the electromagnetic field. These considerations are within the framework of the conventional picture in which neutral lepton currents are conspicuous by their absence. Motivation is derived from the need to establish the relevance, or irrelevance, of any conceivable physical observation of these currents to a theory of weak interactions. The couplings associated with both the vector and axial vector lepton currents are investigated in a simple model. Some physical processes that may be expected to carry the signature of neutral lepton currents are also considered. (auth)

37957 DYNAMICAL APPROACH TO THE UNITARY-SYMMETRY MASS FORMULA BASED ON ω-φ MIXING. J. J. Sakurai (Univ. of Chicago). Phys. Rev., 132: 434-41 (Oct. 1, 1963). (EFINS-63-28)

Possible dynamical mechanisms that give rise to the unitary-symmetry mass formula of Gell-Mann and Okubo are discussed with special emphasis on a model based on ω-φ mixing. In addition to accounting for the mass formula in a rather natural manner, the ω-φ mixing model has the following distinctive features: (1) It explains why the mass formula fails for the vector meson octet. (2) It requires $m_\rho < m_M$ provided $m_\pi < m_K$. (3) It leads to $|m_\Sigma - m_N| \gg |m_\Sigma - m_\Lambda|$, provided the couplings of the vector mesons to the baryons are predominantly of the F type (as expected from the point of view of the conserved-vector-current theory). (4) It justifies the conjecture that it is more proper to use, in the mass formula, $(\text{mass})^2$ for the mesons, but just the mass for the baryons. (5) The corrections to the mass formula are expected to be of the order of a few per cent if the major contribution to the self-energies of the strongly interacting states comes from the region of a few Bev. A quantitative estimate of the ω-φ mixing is made, and it is shown that the observed 1020-Mev φ meson (the observed 780-Mev ω meson) is about a 60 to 40 mixture (a 40 to 60 mixture) in intensity of the $T = 0$ member of a unitary octet and a unitary singlet. It is shown that a pair of mass formulas of the Gell-Mann–Okubo type are self-consistent provided the cutoff momentum (in the perturbation-theoretic sense) is much greater than a typical difference within a unitary multiplet. (auth)

37958 DIFFRACTION SCATTERING AND SINGULARITIES IN THE ANGULAR MOMENTUM PLANE. I. R. Gatland and J. W. Moffat (Research Inst. for Advanced Studies, Baltimore). Phys. Rev., 132: 442-7(Oct. 1, 1963).

The singularities in the angular momentum plane, which describe the vacuum intermediate state dominating high-energy scattering, are assumed to consist of a single Regge pole and a fixed branch cut. If the energy variable ($\sqrt{s}$) only enters the equations in the normalized form $w = s/2M_1M_2$, where M_1 and M_2 are masses of the particles, the value of w for lower mass interactions (e.g., $\pi-N$) will be much larger than for high mass interactions (e.g., $N-N$), for the same value of the lab energy. In the combined pole and cut model the vacuum pole dominates at lower values of w, and the cut becomes dominant as $w \to \infty$, so that the $p + p$ scattering between 7 and 20 Bev/c will be mainly described by the single vacuum pole, causing the width of the diffraction peak to shrink, while the $\pi^- + p$ scattering between 7 and 17 Bev/c will be described by the fixed cut, which leads to no shrinkage. This permits the $p + p$ and $\pi^- + p$ data to be combined into one. A fit is obtained to the combined $p + p$ and $\pi^- + p$ data for the elastic differential cross section obtained recently by Foley. Another consequence of the vacuum-pole-cut model is that, in the energy range under consideration, the total cross section is not yet constant, but has the form $\sigma_T = a + b/\ln w$, which agrees well with $\pi^+ + p$ scattering data. This behavior of σ_T should also describe the average of the $p + p$ and $\bar{p} + p$ total cross sections. Estimates of a and b using $p + p$, $\bar{p} + p$, and $\pi^+ + p$ data agree with those obtained for $\pi^+ + p$ alone to within 6%. This strongly supports our method of combining $N-N$ and $\pi-N$ scattering data, and is in good agreement with the pole and cut model. A test of the theory can be obtained from experiments on $K-N$ scattering. (auth)

37959 PHOTOPRODUCTION OF LOW-ENERGY CHARGED PIONS FROM DEUTERIUM. J. P. Burq and J. K. Walker (Faculté de Sciences, Orsay, France). Phys. Rev., 132: 447-54(Oct. 1, 1963).

Accurate measurements were made of the π^-/π^+ photoproduction ratio on deuterium, in the gamma-ray energy range 165 to 210 Mev, for several angles: 155°, 125°, 90° (center-of-mass system) and along Baldin's kinematical line. These last data are now contributions: $\pi^-/\pi^+ = 1.20 \pm 0.03$ averaged between 165 and 180 Mev. The others are improvements of the accuracy of previous data. The comparison with Ball's theory, corrected for taking into account the $I = \frac{1}{2}$ phase shifts, gives for the coupling constant Λ for $\gamma-\pi-p$ the value: $0.25 < +\Lambda/e < 0.75$. (auth)

37960 COUPLING-CONSTANT SUM RULES. M. Muraskin (Univ. of Minnesota, Minneapolis) and S. L. Glashow. Phys. Rev., 132: 482-4(Oct. 1, 1963).

Coupling-constant sum rules are derived assuming that the violation of unitary symmetry transforms like the eighth component of unitary spin. This parallels the derivation of the mass sum rule. (auth)

37961 DISPERSION RELATIONS IN STRONG-COUPLING PHYSICS. S. Mandelstam (Univ. of Birmingham, Eng.). Rept. Progr. Phys., 25: 99-162(1962).

A survey is given of the principles underlying dispersion relations in elementary-particle physics, and some of their phenomenological and dynamical applications are treated. The general nature of dispersion relations and their connection with causality are examined, particular emphasis being placed on the role they have recently played in strong-coupling physics. An account is given of the approximation scheme obtained by combining dispersion relations with unitarity and which, it is hoped, will provide a basis for calculations. Proved and conjectured dispersion relations are written down, and the plausibility of the conjectures is discussed. The calculations so far performed, and the results they have achieved, are summarized. (auth)

37962 ELECTRON AS A FUNDAMENTAL ELEMENTARY PARTICLE. [PART] II. Usaku Kakinuma. Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 57: 33-6(June 1963).

The electron as defined in the ideal state has a multiple structure of spherical symmetry. The innermost region of radius $\sqrt{\pi\gamma} \cdot e/C^2$ or $\sqrt{\pi\gamma\hbar/C^3}$ ($\approx 10^{-30}$ cm) occupied by the electron-core contains the electronic mass and charge. The region extending outside the sphere of radius R to infinity is the ordinary electromagnetic field, and the intermediate region lying between the above two is called singular region, where the conventional electromagnetic theories are not applicable. The electron spin is also intimately associated with the state of the core, and a tentative consideration has shown that the magnitude of the magnetic moment of the electron turns out to be $he/2mc^2$. The structure of the position is expounded in a similar way by introducing an idea of negative length inside the positron-core. (auth)

37963 TWO PHOTON EXCHANGE CORRECTOR FOR MUON-ELECTRON SCATTERING. G. Meyer-Pundt (Freiburg i. B.). Z. Naturforsch., 18a: 877(July 1963). (In German)

The formula derived earlier for the scattering of fast electrons on photons (Z. Naturforsch. 15a, 548(1960)) can be transferred, with some logical changes, to the scattering of fast muons on electrons. In muon-electron scattering it is necessary to introduce the parameters for the energy of the incident muon and the scattering angle of the muon in the center of gravity system. The results for $\mu^+ - e^-$ scattering are shown graphically. (J.S.R.)

37964 RELATIVISTICALLY INVARIANT TRANSFORMATIONS IN WAVE FUNCTION SPACE. A. A. Borgardt (Dnepropetrovsk State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 116-22(Aug. 1963). (In Russian)

Transformations in wave space are considered and their corresponding conservation laws are derived. Larmor transformations and reverse transformations of boson masses are examined. Extended Foldy–Tani and Cini–Touschek transformation groups in boson theory are set up (one of them–the analog of the usual FT transformation–has been analyzed previously without being included in the general scheme of the Kemmer theory). (auth)

37965 TRANSVERSE AND LONGITUDINAL STATES OF BOSON FIELDS AND DIBARIC PARTICLES. A. A. Borgardt (Dnepropetrovsk State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 123-7(Aug. 1963). (In Russian)

The physical nature of the restrictions imposed on the solutions of the Klien equations by the Kemmer equations is elucidated. In this connection, second order equations for bosons seem to be more preferable than the Kemmer equations. The extension of Kemmer algebra to the field of matrices possessing inverse ones is investigated and equations are written down for particles with various masses in longitudinal and transverse field states. The wave equations for an intermediate boson in a recently proposed theory of week interaction are similar to the equations of the vector part of the $\beta_\mu(\sigma)$ representation. (auth)

37966 VALIDITY OF THE DOUBLET SYMMETRY HYPOTHESIS AT HIGH ENERGIES. V. N. Streltsov (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 128-30(Aug. 1963). (In Russian)

Attention is directed to the circumstance that the conclusions resulting from doublet symmetry can be made consistent with the corresponding high energy experimental data. (auth)

37967 FIELD THEORY WITH NONLOCAL INTERACTION. II. DYNAMIC APPARATUS OF THE THEORY. D. A. Kirzhnits (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 143-54(Aug. 1963). (In Russian)

It is shown that a space-time (and in particular a hamiltonian) description can be made of a system of fields interacting in a nonlocal manner. Underlying the dynamic apparatus of the theory are renormalized Heisenberg field equations modified in such a way that they automatically lead to a unitary scattering matrix. For this purpose the S-matrix representation introduced in a previous paper is applied in the form of an exponent ordered with respect to charge. The form of the energy-momentum and charge operators and also the form of the field operators in the Schroedinger and interaction representations are also determined. It is shown that irrespective of choice of the form factor, no negative energy difficulties are encountered in nonlocal field theory. (auth)

37968 ANOMALOUS RESONANCE SPIN FLIP OF A PARTICLE IN A MAGNETIC FIELD. Kh. A. Simonyan and Yu. F. Orlov (Erivan State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 173-6(Aug. 1963). (In Russian)

It is shown that if a particle rotates in a constant magnetic field, a weak high frequency radial or azimuthal magnetic field with a frequency equal to the anomalous part of the spin precession frequency should induce resonance spin flip. (auth)

37969 INTERFERENCE PHENOMENA IN RADIATIVE $K^0_{2\pi}$ DECAYS. I. S. Tsukerman. Zh. Eksperim. i Teor. Fiz., 45: No. 2, 188-94(Aug. 1963). (In Russian)

Interference of K^0_1 and K^0_2 decays in a K^0 beam into $\pi^+ + \pi^- + \gamma$ is considered. It is shown that the circular polarization of the γ quanta depends on the magnitude and sign of the K^0_1 and K^0_2 mass difference and on the π-π interaction phase shift in the final states. Angular and energy distribution of γ quanta and π mesons are obtained. The angular correlation of the electron-positron and π-meson pair emission planes in the $K^0 \to \pi^+ + \pi^- + e^+ + e^-$ decay is also investigated and the internal conversion coefficient is estimated. (auth)

37970 MESON PRODUCTION IN NEUTRINO EXPERIMENTS AND THE ISOTOPIC STRUCTURE OF WEAK INTERACTION. Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 202-6(Aug. 1963). (In Russian)

In the weak interaction schemes under discussion it is assumed that the strangeness conserving current of strongly interacting particles is an isotopic vector. It is shown that this hypothesis leads to a number of relations between the cross sections for meson production processes without change of strangeness in collisions of high energy neutrinos and antineutrinos with nucleons. It is assumed that neutral symmetric currents exist. (auth)

37971 INVESTIGATION OF DEUTERON DISINTEGRATION DUE TO NUCLEONS BY THE DIAGRAM SUMMATION TECHNIQUE. V. V. Komarov and A. M. Popova (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 214-27(Aug. 1963). (In Russian)

Integral equations for the interaction amplitudes of three nucleons are derived by the diagram summation technique. The first diagrams corresponding to the first iterations of the equations are considered. Their contribution is calculated in an analytical form. An exact correspondence is established between the contribution of the first diagrams and the results previously obtained in the first approximation of perturbation theory by taking into account particle interactions in the final state. The results are extended to

the case of real nucleons with a spin and isotopic spin. (auth)

37972 REGGE POLE FOR SCATTERING ON A δ POTENTIAL. V. M. Arutyunyan, I. I. Goldman, and G. A. Nagorskii (Erivan Inst. of Physics). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 246-50(Aug. 1963). (In Russian).

Regge trajectories for scattering on a δ potential are investigated. Many of the results apply to potentials that do not possess singularities at zero. (auth)

37973 GRAVITATIONAL TRANSMUTATIONS OF FERMIONS. Yu. S. Vladimirov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 251-9(Aug. 1963). (In Russian)

The density of interaction Lagrangians for gravitational, spinor, and electromagnetic fields is constructed. The effective cross sections for annihilations of fermion pairs into two gravitons, into photons, and gravitons, and for the Compton effect of photons on fermion with transmutation into gravitons are calculated on the basis of quantization of weak gravitational fields. (auth)

37974 FERMION REGGE POLES AND THE COMPTON EFFECT. V. G. Gorshkov, M. P. Rekalo, and G. V. Frolov (Ioffe Inst. of Physics and Tech., Leningrad; Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR; and Radium Inst., Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 285-90(Aug. 1963). (In Russian)

Scattering of photons on spin ½ particles is investigated for large values of s and finite u on the basis of the Regge pole hypothesis. The expression for the scattering amplitude is reduced to an explicitly factorized form. The main qualitative results are the same as those of Gribov for π-N scattering. Asymptotic expressions for the differential cross section and some polarization effects are calculated for scattering into large angles. (auth)

37975 PARTIAL πN SCATTERING WAVES WITH ACCOUNT OF ππ INTERACTION. P. S. Isayev, V. I. Lendel, V. A. Meshcheryakov (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 294-302(Aug. 1963). (In Russian)

The effect of π-π interaction in the T = J = 0 state on the partial π-N scattering waves is investigated by the dispersion relations technique. In the final expressions a transition is made to the static limit which is then compared with the experimental data. The most probable form of the π-π scattering phase shift δ_0^0 is discussed. Relations connecting the interaction contributions to the s and p scattering waves are derived. A number of investigations on π-N scattering are analyzed on the basis of these relations. The consequences of the relations for the static limit are considered. (auth)

37976 POLARIZATION PHENOMENA IN THE COMPTON EFFECT FOR A MOVING ELECTRON AND THE POSSIBILITY OF OBTAINING BEAMS OF POLARIZED γ-QUANTA. F. R. Arutyunyan, I. I. Goldman, and V. A. Tumanyan (Erivan Inst. of Physics). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 312-15(Aug. 1963). (In Russian)

The polarization of γ quanta produced as a result of Compton scattering of soft photons on relativistic electrons is considered. It is shown that the degree of polarization of the indicated photons may approach 100% in the case of photons scattered at a given azimuthal angle as well as in the case of averaging of the polarization states over the angle. For this reason Compton scattering of relativistic electrons may be used as an effective method for obtaining polarized γ quanta. (auth)

37977 PHOTON EMISSION BY A FAST PARTICLE INTERACTING WITH ELEMENTARY EXCITATIONS IN MATTER. M. I. Ryazanov. Zh. Eksperim. i Teor. Fiz., 45: No. 2, 333-6(Aug. 1963). (In Russian)

It is shown that when an elementary excitation is absorbed by a fast particle a hard quantum may be emitted with a probability that in some cases appreciably exceeds that for bremsstrahlung. (auth)

37978 ON THE TRAJECTORY OF REGGE VACUUM POLES. B. V. Geshkenbein and B. L. Ioffe (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 346-8 (Aug. 1963). (In Russian)

Restriction on the behavior of a vacuum pole l_0 (t) is imposed on the basis of the following properties of $l_0(t)$: $l_0(t) = 1$; $l_0(t)$ is an analytic function of t in the complex plane of t with a cut along the real axis from $4\mu_\pi^2$ to infinity. (auth)

37979 PHASE SHIFTS OF COULOMB pp SCATTERING. N. P. Klepikov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 376-7(Aug. 1963). (In Russian)

The importance of accounting for relativistic and form-factor corrections to the phase shifts of Coulomb proton-proton scattering is pointed out. (auth)

37980 MOMENTUM PULSE SPECTRA OF BARYONS IN INELASTIC INTERACTIONS OF FAST PIONS WITH NUCLEONS. V. S. Barashenkov, D. I. Blokhintsev, E. K. Mikhul, I. Patera, and G. D. Semashko (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 381-3(Aug. 1963). (In Russian)

Previously it was shown that the momentum spectra of Λ and Σ hyperons produced in inelastic π^--p interactions at T ~ 10 Bev have two maxima for T = 7 Bev, one for p ~ 0.8 Bev/c and the other for p ~ 1.6 Bev. The recoil nucleons have similar spectra. An attempt was made to show that the "two-humped" barion spectra are produced by the resonance interaction of a primary π^- meson with an intermediate particle transmitting the main part of the interaction to the peripheral π-N interactions. (R.V.J.)

37981 ON ONE REACTION IN CROSSED ELECTRON BEAMS. V. D. Mikhailov (Moscow Inst. of Engineering Physics). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 383-5 (Aug. 1963). (In Russian)

An attempt was made to determine qualitatively the energies and angles at which μ-pair production in crossed electron beams becomes larger than in crossed electron-positron beams. An estimate of integral and differential cross sections was made using the Vaitscekker-Williams method. (R.V.J.)

37982 η^0 MESON AND MASS DIFFERENCE OF K_1^0 AND K_2^0 MESONS. S. G. Matinyan (Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 386-8(Aug. 1963). (In Russian)

An assumption that non-leptonic decay of Σ hyperons results in vertical dissociation into $\bar{K}$ mesons and nucleons, followed by $\bar{K}$-π transitions, was offered by S. K. Bose (Phys. Lett., 2: 92(1962)). An attempt is made to evaluate the K-π transition as a uniform polar decay mechanism for η^0 and K into three π mesons through a vertical π meson. The mechanism is a result of recently found quantum numbers for η^0 (0^{--+}) and the universal selection rule $\Delta T = ½$ in K decay, normalized in both cases to the three meson state with T = 1. The transition constant for K-π was evaluated using a model of K_2^0 decay into $\pi^+\pi^-\pi^0$ through an intermediate π^0. (R.V.J.)

37983 ELASTIC SCATTERING OF π^- MESONS ON PROTONS AT 3.5 Bev/c. M. S. Ainutdinov, S. M. Zombovskii, A. A. Pletnikov, Ya. M. Selektor, and V. N. Shulyachenko (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 392-4(Aug. 1963). (In Russian)

Elastic scattering of π^- mesons by protons at 3.5 Bev/c was measured using a 25-cm liquid hydrogen bubble chamber placed in a 14 k Gauss magnetic field. 540 events of elastic scattering were selected by comparing the angles of emissions and secondary particle momenta with anticipated magnitudes for elastic scattering. The total backward scattering was 50 ± 20 μb. Calculations of A(s) showed $A = 7.36 \pm 0.44$ $(Bev/c)^{-2}$. The mean magnitude A(s) for 1.5 to 16 Bev was 7.61. Hence, the assumption that π-p and π-π scattering are determined only by vacuum poles is not in agreement with experimental data. (R.V.J.)

37984 DYNAMIC POLARIZATION OF PROTONS AT 0.5°K. B. S. Neganov, L. B. Parfenov, V. I. Lushchikov, and Yu. V. Taran (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 394-6 (Aug. 1963). (In Russian)

Results from previous experiments on dynamic proton polarization in $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$ crystals with paramagnetic admixtures of Ce and Nd at 1.4 to 1.7°K indicate 51% proton polarization. The results of experiments with a double nitrate crystal containing 0.8% Ce at temperature ~0.5°K are described. A considerable increase in polarization was observed at 0.5 to 1.7°K. An amplification of polarization as a function of the external field at fixed electron paramagnetic resonance, an amplification of the coefficient as a function of superhigh frequencies saturating electron paramagnetic resonance, and proton spin-lattice relaxation time as a function of temperature were analyzed. Experiments at temperatures below 1°K showed that the amplification coefficient was not affected by a sharp temperature drop, and applications of strong magnetic fields and high frequencies resulted in proton polarization close to 100%. Experiments with dynamic proton polarization in polyethylene irradiated by fast neutrons showed that at 0.5°K the nuclear paramagnetic resonance was amplified 20 fold in comparison to $\eta = 30$ at T = 1.6°K. (R.V.J.)

37985 HEAVY MESONS AND THEIR EFFECTS ON THE NN AND $\bar{N}N$ ELASTIC SCATTERING AMPLITUDES. George C. Summerfield. Thesis, East Lansing, Mich., Michigan State Univ., 1962. 108p.

Dispersion relations were developed for the N-N and $\bar{N}$-N elastic scattering amplitudes for neutral, scalar nucleons from causality and unitarity. These were evaluated to fourth order in perturbation theory. The fourth order terms are shown to be about 10% of the pole terms for neutral, scalar nucleons, and low energies, if the coupling constants are not significantly larger than the pion-nucleon pseudoscalar coupling constant. Dispersion relations were developed for the N-N and $\bar{N}$-N elastic scattering amplitudes for charged, spinor nucleons. Mesons with zero strangeness were considered and it is shown that there are ten that interact linearly with the nucleon field, conserving J, P, T, and G. The pole terms of these mesons were determined in the N-N and $\bar{N}$-N elastic scattering amplitudes, and the neutron-neutron, proton-proton and neutron-proton differential elastic scattering cross sections were determined from these pole terms. This gives the differential cross sections in terms of twelve coupling constants and ten masses. (Dissertation Abstr.)

37986 BOUNDARY CONDITION MODEL FOR p-p SCATTERING. Dwight Proffer Saylor. Thesis, Rochester, N. Y., Univ. of Rochester, 1962. 69p.

The construction of a boundary-condition model with potential tails for the proton-proton system is described. This model gives good agreement with experiment in the 40 to 310 Mev energy range. It is shown that the boundary-condition model should give a satisfactory representation of the energy dependence of the s-matrix for all partial waves except the $^1S_0$, if the p-p interaction can be correctly described by a potential and that potential does not differ from one-pion exchange except at ranges corresponding to two-pion exchange and less. That is, the contribution of two, three, and more pion effects should produce chiefly shape-independent effects in p-p scattering. The success of the boundary-condition model can be considered a manifestation of this fact. Application of the boundary-condition method to the nucleon-antinucleon system is discussed and a simplified model is given which, nevertheless, fits the data now available in the energy region where it should apply. (Dissertation Abstr.)

37987 STRONG-COUPLING TREATMENT OF A CHARGED SCALAR MESON FIELD INTERACTING WITH A STATIC EXTENDED SOURCE. Harry Herman Nickle. Thesis, New York, Columbia Univ., 1960. 67p.

A strong-coupling treatment of the charged scalar theory is presented. The treatment starts from the charged scalar Hamiltonian in the form obtained by Pais and Serber [Phys. Rev., 105: 1636(1957)]. Working in a representation in which τ_1 is diagonal, terms proportional to τ_2 and τ_3 are eliminated from the Hamiltonian (to order $1/g^2$) by making two arctangent transformations. This gives the Hamiltonian correct to order $1/g^4$. Then the 1-field is separated into self-field and free field parts. The Hamiltonian now involves two arbitrary functions, the distribution function f (introduced by Pais and Serber) and the self-field v; f and v are chosen so that the variation of the Hamiltonian with respect to π_2 and ϕ_1 vanishes for zero values of the free fields. This leads to the choice f = v, whereas the usual strong-coupling treatment corresponds to the choice f = U. The static isobar spectrum for the lower states gives bound isobar states for $g^2 > 2$, independent of charge. The nonstatic Hamiltonian is expanded in powers of the ratio of free field to self-field, and the normal mode Hamiltonian is chosen to include all free field terms of zero order in g. The normal mode solutions are used to investigate the structure dependence of the fourth-order corrections to the isobar spectrum. The change in the zero-point energy of the 2-field due to the presence of the source gives rise to a logarithmic correction. The other fourth-order corrections to the isobar energy are finite in the limit of vanishing source size. It is shown that the logarithmic correction is just that involved in the charge renormalization. None of the higher order corrections to the isobar spectrum diverge faster than $\log(1/\kappa\alpha)$ raised to some power. Thus the choice f = v leads to an expansion in powers of $\log(1/\kappa\alpha)/g^2$. (Dissertation Abstr.)

37988 THE DISPERSION RELATIONS FOR PION PRODUCTION IN PION NUCLEON COLLISIONS. Ronald Martin Mirman. Thesis, New York, Columbia Univ., 1960. 93p.

The dispersion relations for the process $\pi + N \rightarrow \pi + \pi + N$ were studied. The analytic properties required for the application of the equations are shown to hold to the lowest nontrivial order of perturbation theory. The equations were reduced to a set of coupled integral equations

for the amplitudes for isotopic spin and what is argued to be the most important angular momentum states. The basic assumption is that the scattering takes place only in the 33 state and only around resonance. The approximations necessary for the equations to be reducible to a set of equations which can be solved numerically by a computer were found. The problem of solving the equations by machine is studied. (Dissertation Abstr.)

37989 PARTICLE PRODUCTION AT HIGH ENERGIES. Stuart Lloyd Meyer. Thesis, Princeton, N. J., Princeton Univ., 1962. 133p.

A mass analysis was made of several charged secondary beams coming off an internal target at the Brookhaven Alternating Gradient Synchrotron (AGS). The energy of the internal proton beam which impinged on the target was varied between 10 and 33 Bev. Studies were made at laboratory angles of 45, 90, and 13.25° relative to the primary proton beam for several primary energies and for different internal targets. Yield curves normalized to production at the target are presented for the various particles observed. Corrections were made for multiple Coulomb scattering, diffraction scattering, nuclear absorption and decay when appropriate. The techniques, procedures, and apparatus employed in this work are described and discussed. The statistical model due to Fermi is outlined briefly and comparison of some of the experimental results was made with recent calculations of Hagedorn. A comparison of the backward-angle results with forward-angle data due to others, yielded some evidence that nucleon cascade effects are important in producing the observed spectra, especially at large angles in the laboratory. The yield of deuterons is discussed and at large angles was found to be in rough agreement with abundances predicted on the assumption of the predominance of a pickup process. (Dissertation Abstr.)

37990 LARGE-ANGLE ELASTIC SCATTERING OF NEGATIVE PIONS BY PROTONS AT 1.51, 2.01, AND 2.53 Bev/C. Kwan Wu Lai. Thesis, Ann Arbor, Mich., Univ. of Michigan. 1963. 150p.

The differential elastic scattering cross sections for negative pions on protons were measured at incident momenta of 1.51, 2.01, and 2.53 Bev/c with emphasis on the angular region outside the diffraction peak. The purpose of the experiment was to examine the behavior of the large-angle differential elastic cross section as a function of energy from the energy of the highest known resonance in the pion-nucleon system into the region where the total cross sections appear to be approaching an asymptotic value. The experiment was performed at the Bevatron, using a luminescent chamber system to photograph the tracks of the scattered pion and the recoil proton from a liquid hydrogen target. A total of 2412 elastic scatterings were analyzed at 1.51 Bev/c, 1300 events at 2.01 Bev/c, and 1080 events at 2.53 Bev/c. From the existing data it may be noted that the backward bump, which has a maximum height of 2.1 mb/sr at 900 Mev and 1.1 mb/sr at 1020 Mev, is down to 0.4 mb/sr at 1.51 Bev/c (1.37 Bev), and is not present at 2.01 or 2.53 Bev/c. The angular distributions behind the diffraction peak at 2.01 and 2.53 Bev/c are rougly constant, decreasing from 0.18 mb/sr at 2.01 Bev/c to 0.125 mb/sr at 2.53 Bev/c. Although the data can be taken to suggest some oscillatory structure in this region, they are not inconsistent with an isotropic distribution that might be interpreted as evidence for an S-wave scattering behind the diffraction peak. (Dissertation Abstr.)

37991 A DOUBLE DISPERSION RELATION FOR A CLASS OF NONLOCAL POTENTIALS. James Thomas Cushing. Thesis, Iowa City, Iowa State Univ., 1963. 140p.

Although the Mandelstam representation forms the basis of much of the theoretical work done in high-energy physics today, its validity has been rigorously demonstrated only within the frame-work of nonrelativistic local potential scattering theory. It is often considered to hold for relativistic, many-channel situations. The analytic properties of the scattering amplitude were investigated for a general class of nonlocal potentials. Also, the class of nonlocal potentials considered includes the local ones previously studied, as well as allowing interactions with explicit angular momentum dependence. The nonlocal interaction to be used in the Schrödinger equation, $\Delta\psi(\underline{r}) + k^2\psi(\underline{r}) = \int U(\underline{r},\underline{r}')\psi(\underline{r}')d\underline{r}'$, $\hbar = 2\mu = 1$, μ = reduced mass of scattered particle, was taken to be central and composed of a superposition of a local potential, V(r), and a purely nonlocal, separable one. The form is $U(\underline{r},\underline{r}') = \delta(\underline{r}-\underline{r}')V(r) + \Sigma_{l=0}^{\infty}\epsilon_l u_l(r)u_l(r')P_l(\cos(\hat{\underline{r}},\hat{\underline{r}}'))$, where, $V(r) = \int_{m>0}^{\infty} d\mu\ \gamma(\mu)(e^{-\mu r}/r)$ and $u_l(r) = \Sigma_{j=1}^{N} c_j(l)(e^{-\alpha_j r}/r^{l+1})$. The exact partial-wave scattering amplitudes, A(l,k), were constructed and the analytic properties of the total scattering amplitude, $A(\nu,t)$, considered as a function of the two complex variables ν(energy) and t(momentum transfer), were studied through the partial-wave expansion and the Sommerfeld-Watson transformation. The scattering amplitude can be written as a double dispersion relation with possibly a finite number of pole terms and subtractions. The scattering amplitude for the class of nonlocal potentials considered has an additional cut for $-\infty \le \nu \le -\alpha^2$, which cancels for a purely local potential, and which would not be expected on the basis of a single-channel, nonrelativistic Mandelstam representation. (Dissertation Abstr.)

37992 SOME APPLICATIONS OF DISPERSION RELATIONS; DECAY OF STRONGLY INTERACTING PARTICLES, EFFECT OF PION RESONANCES ON THE PROPERTIES OF KAONS AND PIONS. Samir Kumar Bose. Thesis, Rochester, N. Y., Univ. of Rochester, 1962. 93p.

The decay process of strongly interacting particles was studied in the pole approximation, i.e., when only the effect of dispersion theoretic pole diagrams is retained, to the neglect of all others, in studying the decay process. The cases considered are the π^0 decay, non-leptonic hyperon decays, and the radiative hyperon decays. For the π^0 decay, $\pi^0 \to \gamma + \gamma$, deduction of the Goldberger-Treiman formula is given for this process based on a study of the Low amplitude in nucleon Compton scattering. The radiative hyperon decays were studied on the basis of the pole approximation of Feldman, Matthews, and Salam. A further application of pology was studied; that of the determination of neutron form factor from deuteron electrodisintegration. The effects of the K-π and pion resonances on the electromagnetic properties of the pion and Kaon were studied. The electromagnetic form factor of the Kaon was studied on the basis of Mandelstam representation and a solution for the isovector form factor found which displays the effect of the pion and Kaon resonances. This solution was applied to the dispersion theoretic relationship between the $(K^+ - K^0)$ mass difference and the Kaon form factor. It was observed that the correct sign and the magnitude of the mass difference can be obtained on the basis of two 3π resonances. The problem of the $(\pi^+ - \pi^0)$ mass excess was investigated on the basis of the observed 2π resonance and it was found that the $(\pi^+ - \pi^0)$ mass excess

can be fully explained by the theory. The Kaon form factor in the time-like region was then studied with reference to the proposed colliding electron position beam experiments. The mass difference between K_1^0 and K_2^0 coming from higher order weak interactions was also studied. (Dissertation Abstr.)

Neutron Physics

37993 (GA-4426) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending June 30, 1963. J. C. Young, J. R. Beyster, J. R. Brown, D. H. Houston, J. Kirkbride, J. U. Koppel, G. D. Trimble, and J. A. Young (General Atomic Div. General Dynamics Corp., San Diego, Calif.). July 26, 1963. Contract AT(04-3)-167. 48p.

Decay constant and modal analysis measurements were performed in a U^{235}-water critical assembly, and infinite-medium neutron spectra in water poisoned with a 1/V absorber were measured at various pressures and temperatures. The results were compared with theoretical predictions. Neutron penetration of water shielding was also measured. Theoretical work involved models and codes for neutron thermalization in ZrH, Be, and water. (D.C.W.)

37994 (IA-761(App.)) THE DSN CODE FOR THE PHILCO-2000 COMPUTER. L. Gitter, M. Szac, and S. Yiftah (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Feb. 1963. 79p.

The DSN and auxiliary MIX, CRT, and CRT-1 programs used for the numerical solution of the PHILCO-2000 of the transport equation previously reported in IA-761 are described. Formulas, sample input and output, and program listings are included. (D.C.W.)

37995 (KAPL-M-EC-32) SPEC—A NEUTRON SPECTROMETER TRANSMISSION DATA REDUCTION PROGRAM FOR THE PHILCO 2000 DIGITAL COMPUTER. J. N. Brazos, A. L. Liedel, and J. A. Warrington (Knolls Atomic Power Lab., Schenectady, N. Y.). July 15, 1963. Contract W-31-109-eng-52. 84p.

The computer program SPEC, which computes the absorber content of samples from neutron transmissions measured in a crystal spectrometer, is described. Samples include types that contain absorber compounds embedded in matrix materials that also display absorption and scattering properties. For two-phase systems the effective particle sizes and microscopic shieldings of the absorber materials are also computed. The computational equations, program listing, and sample input and output are included. (auth)

37996 (TID-17646) NEUTRON THERMALIZATION AND DIFFUSION IN NON-ISOTHERMAL MEDIA. Bal Raj Sehgal (Argonne National Lab., Ill.). Oct. 1962. Contract [W-31-109-eng-38]. 46p. (UAC-6984)

The effect of an imposed non-uniform temperature distribution on the processes of neutron thermalization and neutron diffusion in a moderator system is studied. The neutron thermalization and diffusion problem, i.e., the so-called consistent P_1 approximation to the neutron Boltzmann equation, is formulated. The neutron transfer cross sections for s and p scattering are evaluated under the assumptions: the moderator behaves as a mono-atomic gas; the neutron-atom collisions are elastic; and the scattering is spherically symmetric in the center of mass system of the neutron-atom. The P_1 approximation equations are then simplified by an order of magnitude analysis. The simplification consists of taking $l^2/L^2 \ll 1$ and $l_m/L \ll 1$, where l is the neutron mean free path, l_m is the molecular mean free path and L is a characteristic dimension of the moderator system of the order of magnitude of $\vec{\nabla}T/T$. The simplified P_1 problem is then solved for the special cases of a non-absorbing hydrogen (M = 1) gas moderator, and a non-absorbing heavy gas moderator. The neutron current is evaluated for these cases, and it shows the contributions due to both the local neutron concentration gradient and the local temperature gradient. The coefficients of neutron concentration and thermal diffusive flows, D_ϕ and D_T are evaluated as a function of the moderator atom mass. It is found that the neutron thermal diffusive flow is in the direction of the negative temperature gradient. The value of the coefficient D_T decreases with the increase of mass of the moderator atoms. In the case of the hydrogen gas moderator system, if $|\vec{\nabla}\phi/\phi| \simeq |\vec{\nabla}T/T|$, the magnitude of the thermal diffusive flow is one half of that of the neutron concentration diffusion flow. 28 references. (auth)

37997 (AEC-tr-5734) PROCEEDINGS OF THE WORKING CONFERENCE ON SLOW NEUTRON PHYSICS (7-12 DECEMBER, 1961). Translation of "Materialy Rabochego Soveschaniya po Fizike Medlennykh Neitronov (7-12 Dekabrya 1961 Goda)," Obedinennyi Institut Yadernykh Issledovanii, Dubna, 1962, God. 299p.

Separate abstracts were prepared for fifty-six of the papers. Seven other papers were previously abstracted in NSA. (D.C.W.)

37998 (AEC-tr-5734(p.1-2)) APPLICATION OF AN OPTICAL MODEL TO AVERAGED CROSS SECTIONS FOR LOW-ENERGY NEUTRONS. P. E. Nemirovskii. (Translation)

The optical model was used to calculate the power functions of the p- and s-wave as well as the cross sections for radiative capture. The vital role of the absorption of p-neutrons at 10 kev and d-neutrons near 100 kev in the region of broad p-and -d resonances was demonstrated. The effect of inelastic scattering on radiative capture was also investigated with the optical model. (D.C.W.)

37999 (AEC-tr-5734(p.3-6)) ENERGY DEPENDENCE OF THE CROSS SECTIONS OF THE REACTION (n,γ) ON THE NUCLEI OF NINE ELEMENTS. Yu. P. Popov and F. L. Shapiro (Translation)

The energy dependence of the effective neutron capture cross sections for Br, Rb, Nb, Rh, In, Sb, I, Cs, Ir, and separated Rb^{85} were measured. The results agree well with other data, and shell effects appear rather distinctly. The cross sections for Rb^{87} and Rb^{85} differ greatly. (D.C.W.)

38000 (AEC-tr-5734(p.7-10)) INVESTIGATIONS IN THE FIELD OF NEUTRON SPECTROMETRY ON THE VVR-M ATOMIC REACTOR OF THE INSTITUTE OF PHYSICS, ACADEMY OF SCIENCES UKRANIAN SSR. V. P. Vertebnyi, M. F. Vlasov, V. V. Kolotyi, A. N. Maistrenko, R. G. Ofengenden, M. V. Pasechnik, Zh. I. Pisanko, and Yung-t'ai Chu. (Translation)

The analyzers and choppers used in neutron spectrometry by the time-of-flight method at the VVR-M reactor are described. The total cross sections on isolated levels of Ag, Au, and In were measured by this method in good agreement with BNL-325. Measurements on the transmission of Re revealed apparently new levels at 14.7, 16.2, 27.5, 33.0, 40.25, and 53.6 ev. Parameters for three Re levels were also determined. (D.C.W.)

38001 (AEC-tr-5734(p.11-19)) NEUTRON-SPECTROSCOPIC INVESTIGATIONS ON THE LINEAR ELECTRON ACCELERATOR OF THE ATOMIC ENERGY INSTITUTE, ACADEMY OF SCIENCES USSR. Yu. V. Adamchuk, L. S. Danelyan, B. V. Efimov, B. F. Gerasimov, V. S. Zenkevich, S. S. Moskalev, T. A. Mostovaya, M. I. Pevzner, V. V. Safronov, and N. N. Flerov. (Translation)

The properties and facilities of the linear accelerator that make it useful for neutron spectroscopic studies by the time-of-flight method are outlined, and apparatus being used to measure various cross sections, capture gamma spectra, and fission product mass distributions are briefly described. Some interesting preliminary results are new levels in the total cross sections of Te isotopes and the equivalence of the levels of the even-even isotopes. (D.C.W.)

38002 (AEC-tr-5734(p.20-4)) TOTAL NEUTRON CROSS SECTIONS OF EVEN-EVEN ISOTOPES OF MOLYBDENUM. Yu. V. Adamchuk, S. S. Moskalev, and M. I. Pevzner. (Translation)

The total neutron cross sections of Mo^{92}, Mo^{94}, Mo^{98}, and Mo^{100} were measured by the transit time method. Resonance levels determined for the isotopes are listed, as well as neutron spins calculated for some Mo^{98} resonances. (D.C.W.)

38003 (AEC-tr-5734(p.25-6)) DETERMINATION OF THE POWER FUNCTION ACCORDING TO MEASUREMENTS OF THE TRANSPARENCY FOR E_n FROM 40 TO 400 kev. E. A. Koltypin and G. B. Yan'kov. (Translation)

The transparencies of the separated isotopes Ni^{62}, Se^{80}, Cd^{114}, Sn^{118}, W^{182}, and Th^{232} to 40 to 400-kev neutrons coming directly from the source and for neutrons that had passed through a filter of the same element were measured. From the transparency differences, the power functions (ratio of average reduced level width to average distance between levels) for Ni^{62}, Se^{80}, Cd^{114}, and Sn^{118} were determined and were compared with optical model calculations and other data. The transparency differences for W^{182} and Th^{232} were zero. (D.C.W.)

38004 (AEC-tr-5734(p.27-8)) MEASUREMENT OF THE SHAPE ELASTIC CROSS SECTION BY THE SELF-SCREENING METHOD. A. Andreeff. (Translation)

The shape elastic cross sections for Ca^{40}, V^{51}, Co^{59}, Nb^{93}, Rh^{103}, In^{115}, Pr^{141}, Ho^{165}, Au^{197}, and Bi^{204} were measured by using a target thickness such that neutrons with resonance energies were scattered out of the beam. The effective nuclear radius as a function of A was also obtained. The In and Ho values are smaller than those predicted by the optical model. The In nucleus seems to interact with a neutron as if it were a hard sphere. (D.C.W.)

38005 (AEC-tr-5734(p.29-36)) INTERFERENCE EFFECTS IN THE FISSION CROSS SECTIONS OF U^{235} AND Pu^{239}. K. G. Ignat'ev, I. V. Kirpichnikov, and S. I. Sukhoruchkin. (Translation)

The fission and radiative capture cross sections of U^{235} and Pu^{239} were derived from the measured total cross sections and η's. The capture cross sections showed no interference effects, while the fission cross sections revealed strong interferences and required special formulas for their analysis. Information on level spins and interferences was obtained. (D.C.W.)

38006 (AEC-tr-5734(p.37-41)) INVESTIGATION OF THE TRIPLE FISSION OF U^{235} AND Pu^{239} FOR THERMAL NEUTRONS. M. Dakowski, M. Sowinski, Se Don Sik, and Z. Wajdman. (Translation)

The energy distributions of long-range alpha particles from the triple fission of Pu^{239} and U^{235} were obtained using a CsI scintillation crystal. The two distributions have different shapes although the energies and energy spreads are approximately the same. The ratio of the cross section of triple fission/cross section of double fission for the 0.3-ev Pu^{239} resonance was also examined. (D.C.W.)

38007 (AEC-tr-5734(p.42-7)) CHARACTERISTICS OF THE IBR AS A NEUTRON SPECTROMETER. G. I. Zabiyakin, L. B. Pikel'ner, Yu. Ya. Stavisskii, I. M. Frank, F. L. Shapiro, and Yu. S. Yazvitskii. (Translation)

The IBR reactor, its facilities (beam channels, etc.), and the apparatus used with it in measurement of various cross sections, capture gamma spectra, and transmission are briefly described. The reactor gives only a small background in the measurements and provides sufficient resolution and neutron intensities for most studies. (D.C.W.)

38008 (AEC-tr-5734(p.48-51)) INVESTIGATION OF THE TOTAL NEUTRON CROSS SECTIONS OF ELEMENTS WITH THE LNF PULSED REACTOR. Nai-yen Wang, I. Vizi, E. N. Karzhavina, A. B. Popov, and Yu. S. Yazvitskii. (Translation)

The total neutron cross sections of Rh and Tb were measured on a high-resolution time-of-flight spectrometer, and their transmission curves were calculated. In Rh previously unknown weak levels at 99.4, 110.7, 114, 179, and 205 ev were detected. Parameters for all Rh levels are listed. For Tb, several levels previously considered to be single levels were separated into pairs of levels. (D.C.W.)

38009 (AEC-tr-5734(p.52-6)) INVESTIGATION OF NEUTRON RESONANCES USING A CAPTURE GAMMA-RAY DETECTOR. Kim Hi Sang, L. B. Pikel'ner, M. I. Pshitula, Ling-yen Ch'eng, and E. I. Sharapov. (Translation)

The spins, radiation widths, energies, etc., of several Rh levels were obtained from a time spectrum (the analysis theory is outlined) measured by the time-of-flight method on the pulsed fast reactor (IBR). A liquid scintillation detector consisting of para-terphenyl and POPOP in toluene with methyl borate added to it was used. A number of very weak levels with a reduced width <0.03 Mev, perhaps due to p-wave neutrons, were noted. (D.C.W.)

38010 (AEC-tr-5734(p.57-61)) MEASUREMENT OF THE TOTAL EFFECTIVE CROSS SECTIONS OF TANTALUM USING A MECHANICAL NEUTRON SELECTOR. R. Ya. Doil'nitsyn, L. P. Kham'yanov, and V. A. Parfenov. (Translation)

The total effective cross sections of Ta samples were measured with a mechanical neutron chopper. Partial cross sections were derived from the transmission data, and a partial areas treatment of the transmission curve gave the energies, widths, radiation widths, etc., of Ta levels from 4 to 200 ev. The 18.6-ev level appeared only weakly. (D.C.W.)

38011 (AEC-tr-5734(p.62-8)) STATISTICS OF THE NUCLEAR LEVELS (THE DAISON THEORY). Ya. A. Smorodinskii. (Translation)

Daison's work on the statistics of nuclear levels is summarized. Derivation of his level distribution is outlined, along with the calculation of the probability of finding a level at a given distance from an initial level. (D.C.W.)

38012 (AEC-tr-5734(p.69-70)) PROPERTIES OF NUCLEAR RESONANCE LEVELS EXCITED BY SLOW NEUTRONS. S. I. Sukhoruchkin. (Translation)

A survey of experimental material on nuclear levels and their transitions was presented. The ability of various nuclear models to explain level and transition phenomena and properties was also considered. (D.C.W.)

38013 (AEC-tr-5734(p.71)) ANGULAR CORRELATIONS OF RESONANCE CAPTURE γ RAYS. K. G. Ignat'ev, I. V. Kirpichnikov, and S. I. Sukhoruchkin. (Translation)

A method of determining the spins of levels of neutron-excited even-even nuclei by measuring the correlation in the two-step transition to the ground state is briefly described. (auth)

38014 (AEC-tr-5734(p.72-3)) AN ATTEMPT TO DETECT INTERFERENCE IN THE (n,γ) CROSS-SECTION OF HAFNIUM. K. G. Ignat'ev, I. V. Kirpichnikov, and S. I. Sukhoruchkin. (Translation)

The gamma spectrum of Hf^{178} neutron resonances was obtained by placing a gamma detector and a Hf sample at the end of the transit distance of a neutron selector. Intense lines with energies of about 5.5 Mev were observed for 1.1 and 2.4-ev resonances, but the partial cross section displayed no interference between the two resonances. (D.C.W.)

38015 (AEC-tr-5734(p.74-82)) CASCADE γ RADIATION IN THE REACTION (n,γ) ON SLOW NEUTRONS. I. V. Estulin, A. S. Melioranskii, and L. F. Kalinkin. (Translation)

Experiments on the properties of excited nuclear levels involving detection of γ-γ coincidences are surveyed, and a method for measuring coincidences of soft gamma rays is described. A scheme for low-lying Rh^{104} levels and their transitions was obtained by this method. An interpretation of the excited levels of Cs^{134} and Ho^{166} is also undertaken. (D.C.W.)

38016 (AEC-tr-5734(p.83-5)) ON INTERFERENCE IN THE RADIATION CAPTURE CROSS-SECTION OF NEUTRONS BY GOLD IN THE RESONANCE 4.9 EV. B. Kardon, D. Kish, and G. S. Samosvat. (Translation)

Interference between potential and resonance capture was observed in the gamma spectrum from thermal neutron capture for the 4.9 ev level in Au^{197}. (D.C.W.)

38017 (AEC-tr-5734(p.87)) INTERNAL FORMATION OF PAIRS DURING THE CAPTURE OF NEUTRONS IN Cl^{35}. L. Meyer. (Translation)

The angular correlation between the electron and positron during internal pair formation was measured from photographs obtained by passing a filtered thermal neutron beam through a polyvinyl chloride target film in a diffusion camera. High-energy gamma transition multiplicities in neutron capture can be determined from these data. (D.C.W.)

38018 (AEC-tr-5734(p.88-90)) NEUTRON CAPTURE GAMMA RAYS FROM MERCURY. Hans-Ulrich Gersch. (Translation)

A magnetic Compton recoil spectrometer was used to obtain the capture gamma spectrum of Hg with a resolution of 1.6% (1% above 3 Mev). Incomplete agreement with previous results was obtained. The Hg^{200} level and transition scheme, complete with level spins, is given. (D.C.W.)

38019 (AEC-tr-5734(p.94)) THE USE OF COBALT MIRRORS FOR THE POLARIZATION OF THERMAL NEUTRONS. Yu. A. Murav'ev, B. A. Obinyakov, and Yu. A. Prokof'ev. (Translation)

A thermal neutron beam with polarizations as high as 90 ± 10% was obtained by the method of reflection from a magnetized Co mirror on the IRT-1000 reactor. The flux in the central part of the beam was about 1.2×10^6 neutrons/sec. (D.C.W.)

38020 (AEC-tr-5734(p.98-101)) DIRECT DETECTION OF ANOMALOUSLY DECREASED ABSORPTION OF THERMAL NEUTRONS DURING DIFFRACTION ON A NONMOSAIC CRYSTAL. D. Zippel. (Translation)

An experiment on the direct detection of anomalous absorption of thermal neutrons in ideal In–Sb crystals is described. An anomalous linear coefficient of absorption operating for a given diffraction case is determined from measurements on the intensity of reflection from crystals of different thicknesses and is compared with the normal linear absorption coefficient. (D.C.W.)

38021 (AEC-tr-5734(p.102-3)) INCREASING THE EFFECTIVENESS OF ANALYZERS OF CIRCULAR POLARIZATION OF γ RAYS. Yu. A. Prokof'ev and V. P. Martem'yanov. (Translation)

The use of a magnetized absorber of the 50% iron–cobalt alloy, Permendur, instead of an iron absorber, was found to improve the efficiency of a gamma circular polarization analyzer. (D.C.W.)

38022 (AEC-tr-5734(p.104-6)) ON ONE POSSIBILITY OF INVESTIGATING THE TIME INVARIANCE OF NUCLEAR FORCES. P. A. Krupchitskii. (Translation)

An experiment by which the contribution of the time-odd portion of the hamiltonian of the nuclear forces F_{odd} could be found with an accuracy no less than 5% of the total hamiltonian of the interaction of F in a relatively short measurement is outlined. (D.C.W.)

38023 (AEC-tr-5734(p.107-8)) MEASUREMENT OF THE EFFECTIVE ABSORPTION CROSS-SECTION OF Au FOR THERMAL NEUTRONS. Ch. Toic, N. Mateescu, and P. Timis. (Translation)

The effective cross section of Au in the region 5.7–8.8 Å was measured by the time-of-flight method using a neutron chopper. Extrapolation of this cross section according to the 1/v law gave an effective absorption cross section (v = 2200 m/sec) of 98.9 ± 0.3 barns. (D.C.W.)

38024 (AEC-tr-5734(p.109-12)) THERMAL NEUTRON ACTIVATION CROSS SECTIONS OF SHORT-LIVED ISOMERIC STATES. K. F. Alexander and H. F. Brinckmann. (Translation)

The total neutron absorption cross sections of Na^{23}, Ge^{70}, Ga^{71}, and Yb^{174} and the activation cross sections of the resultant isomeric states (Na^{24}, Ge^{71}, Ga^{72}, and Yb^{175}) were determined; and the ratios of the latter cross sections to the former were compared to theoretical values. The results confirm the isomeric ratio rule. (D.C.W.)

38025 (AEC-tr-5734(p.114-18)) MULTICHANNEL SYSTEMS OF REGISTRATION OF THE NEUTRON PHYSICS LABORATORY, UNITED NUCLEAR RESEARCH INSTITUTE. G. I. Zabiyakin. (Translation)

The development of multidimensional recording systems and of automated processing of the experimental data is discussed. (D.C.W.)

38026 (AEC-tr-5734(p.119-39)) INELASTIC EFFECTS IN THE SCATTERING OF NEUTRONS IN LIQUIDS AND SOLIDS. PART I. NONMAGNETIC SUBSTANCES (SURVEY). E. A. Janik. (Translation).

Some problems in the investigation of structures by neutron scattering on noninteracting molecules, neutron inelastic scattering on crystals, and neutron scattering in liquids are discussed. Theory, data analysis, and experimental-theoretical agreement are reviewed. (D.C.W.)

38027 (AEC-tr-5734(p.140-52)) INELASTIC EFFECTS IN THE SCATTERING OF NEUTRONS IN LIQUIDS AND SOLIDS. PART II. MAGNETIC SUBSTANCES (SURVEY). Adam Wanic. (Translation)

Theory, methods, and experimental and theoretical results for investigations of spin system dynamics in magnetic substances by neutron magnetic scattering are reviewed. (D.C.W.)

38028 (AEC-tr-5734(p.164-6)) ANGULAR DISTRIBUTION OF THE SCATTERING OF NEUTRONS ON ETHYLENE AND PROPYLENE. D. Baily, V. Tarine, and S. Todireanu. (Translation)

The angular distributions of slow neutrons scattered on ethylene, propylene, H_2, O_2, and N_2 were measured. A correction coefficient for the effect of neutron scattering on the walls of the gas container was calculated. Preliminary results are given. (D.C.W.)

38029 (AEC-tr-5734(p.167-8)) ON THE RECONSTRUCTION OF THE LAW OF DISPERSION OF PHONONS ACCORDING TO THE NONCOHERENT SCATTERING OF SLOW NEUTRONS. Yu. M. Kagan and O. G. Chicherin. (Translation)

The inverse problem arising from the reconstruction method was solved for the phonon spectrum of V. A set of reaction constants at which the quadratic difference of the corresponding calculated and experimental spectrum reaches a minimum was sought. Two close minima were obtained, and the central interaction constant for the first coordination sphere was found to have the most significance. (D.C.W.)

38030 (AEC-tr-5734(p.186-7)) THE SCATTERING OF SLOW NEUTRONS ON THE NUCLEI OF IMPURITIES IN A CRYSTAL. Yu. M. Kagan and Ya. A. Iosilevskii. (Translation)

The results of an investigation of neutron inelastic scattering by the previously developed method of solving the problem of oscillations of the impurity nucleus in a crystal without optical branches are presented. (D.C.W.)

38031 (AEC-tr-5734(p.188-92)) AN INVESTIGATION OF THE MAGNONS IN A CRYSTAL OF FRANKLINITE BY THE METHOD OF NEUTRON SCATTERING. K. Walia, A. Wanic, and A. Murasik. (Translation)

The peaks of diffusion reflection (scattering) of monochromatic neutrons from a franklinite crystal at liquid air temperature were measured. The peak characteristics indicate their inelastic-magnetic origin, and a comparison of the total width (at the base) of the peaks with theoretical width calculations gave evidence for a quadratic magnon dispersion law. (D.C.W.)

38032 (AEC-tr-5734(p.194-5)) A STUDY OF THE INELASTIC SCATTERING OF COLD NEUTRONS ON BIPHENYL. M. G. Zemlyanov and N. A. Chernoplekov. (Translation)

The spectrum of neutrons inelastically scattered by polycrystalline biphenyl at 300°K is presented. Two previously unobserved lines (λ_1 = 2.23 Å, λ_2 = 3.25 Å) are noted. λ_1 apparently corresponds to intramolecular motions, while λ_2 corresponds to rotational motion of the molecule as a whole around an axis perpendicular to the plane of the molecule. (D.C.W.)

38033 (AEC-tr-5734(p.196-8)) AN INVESTIGATION OF THE PHONON SPECTRUM OF VANADIUM ACCORDING TO THE INELASTIC SCATTERING OF COLD NEUTRONS. N. A. Chernoplekov, M. G. Zemlyanov, and A. G. Chicherin. (Translation)

The spectrum of cold neutrons inelastically scattered by V was obtained with a high-resolution time-of-flight neutron spectrometer. Analysis of the data gave the V phonon spectrum. The energy position of spectrum points agreed with other measurements, but the maximum and minima showed differences indicative of a great noncentral interaction influence in the lattice. (D.C.W.)

38034 (AEC-tr-5734(p.199-202)) INVESTIGATIONS OF THE SCATTERING OF COLD NEUTRONS BY SMALL ANGLES IN ORDERED ALLOYS CLOSE TO THE KURNAKOV POINT. N. Kroo and L. Pal. (Translation)

The temperature dependence of the scattering of neutrons filtered by BeO in B-brass near the vector (000) of the reciprocal lattice was measured. The existence of a maximum of the total effective cross section at the ferromagnetic transition temperature indicates critical neutron scattering. Support for the hypothesis of ferromagnetic region formation in the disordered phase appeared as three maxima expected on the basis of the hypothesis. (D.C.W.)

38035 (AEC-tr-5734(p.210-12)) INVESTIGATION OF THE DISPERSION LAW OF PHONONS IN A MONOCRYSTAL. J. Sosnowski and J. Kozubuwski. (Translation)

The intensity of neutrons inelastically scattered by a Cu monocrystal was obtained as a function of the phonon wave length, using a triaxial neutron spectrometer. Neutron peaks due to phonon annihilation for transverse and longitudinal polarization were observed, and the monocoherent elastic peak from Cu contains a noncoherent elastic peak from V. (D.C.W.)

38036 (AEC-tr-5734(p.213-17)) THE INTERACTION OF NEUTRONS WITH MOLECULES IN THE REGION OF HIGH ENERGIES. Yu. S. Sayasov and G. K. Ivanov. (translation)

Theory associated with the dissociation of molecules, excitation of high oscillatory levels, and electronic transitions during neutron scattering by molecules at chemical bond (D) energies is summarized. (D.C.W.)

38037 (AEC-tr-5734(p.219-21)) CALCULATIONS OF THE DIFFERENTIAL SCATTERING CROSS-SECTIONS OF SLOW NEUTRONS IN THE APPROXIMATION OF AN ISOTROPIC BOND OF THE ATOM. V. F. Turchin, V. V. Smelov, and G. A. Ilyasova. (Translation)

The development of expressions for calculating the differential scattering cross sections of neutrons on bonded atoms for use in calculations of reactor neutron spectra is outlined. Experimental and theoretical values for the total cross section for water are shown to have only small discrepancies apparently due to the hydrogen atom bond in water. (D.C.W.)

38038 (AEC-tr-5734(p.222-6)) SCATTERING OF NEUTRONS WITH ENERGIES OF ABOUT 5 EV IN GRAPHITE AND LiF. T. A. Machekhina, Z. I. Ogzheval'skii, and F. L. Shapiro. (Translation)

The scattering of neutrons on graphite and LiF at about 5 ev was measured by using Au resonance filters in conjunction with the time-of-flight method. The curves of the count rate dependence on the neutron transit time had asymmetric dips due to repeated scattering and the presence of nuclei of different masses. Energy dispersion during scattering produced a broadening in the graphite curve dips. (D.C.W.)

38039 (AEC-tr-5734(p.227-31)) A SETUP FOR MEASUREMENTS WITH COLD NEUTRONS. V. V. Golikov, F. L. Shapiro, A. Szkatula, and J. Janik. (Translation)

The high-resolution time-of-flight cold neutron spectrometer at the Neutron Physics Laboratory is described, and sample spectra for cold neutrons elastically scattered on V and quasi-elastically scattered on water are included. Resolutions of 1 and 2% were obtained as well as high scattered neutron fluxes. Evidence for a rather significant lifetime of the water molecule in the quasi-crystal was observed in the water spectrum along with two liquid-neutron energy transfers of 6×10^{-4} and 3×10^{-4} ev. (D.C.W.)

38040 (AEC-tr-5734(p.232-4)) A NEUTRON CRYSTAL SPECTROMETER. Szczesny Krasnicki. (Translation)

A neutron crystal spectrometer designed for measuring the effective scattering cross sections of slow neutrons and the magnon scattering of neutrons on magnetic crystals and for energy analysis of neutrons inelastically scattered on magnetic crystals is described. (D.C.W.)

38041 (AEC-tr-5734(p.240-3)) MULTIROTOR MECHANICAL NEUTRON CHOPPERS. E. Ya. Doil'nitsyn, L. P. Kham'yanov, and P. S. Klemyshev. (Translation)

Two neutron choppers (particularly their rotor phasing arrangements) are described. The three-rotor chopper with mechanical cog-wheel connections for phasing provides low gamma and neutron background for capture gamma spectra measurement, while the two-rotor chopper with electromagnetic phasing gives low background and resolutions of 0.01 to 0.04 μsec/m. (D.C.W.)

38042 (AEC-tr-5734(p.244-6)) CHARACTERISTICS OF THE ATOMIC PHYSICS INSTITUTE NEUTRON CHOPPER WITH CURVED SLITS. Ch. Toic, N. Mateesuu, P. Pirlogea, K. Radulescu, P. Timis, and V. Vasiliu. (Translation)

The design and performance of a curved-slit neutron chopper for cold neutron spectrometry by the time-of-flight method are briefly described. (D.C.W.)

38043 (AEC-tr-5734(p.251-4)) INVESTIGATIONS TO DETERMINE THE CONDITIONS OF THE BEST SHIELD AS APPLIED TO NEUTRON DIFFRACTION EXPERIMENTS ON THE VVR-S REACTOR. K. Kleinschtuck and D. Zippel. (Translation)

Bismuth filters (high thicknesses desirable) were found to have their best effect as thermal neutron filters when placed on the bottom of the experimental channel. Tungsten was found to be more suitable than Fe and Ni as an absorber for weakening the primary beam between the monochromator crystal and the counter. (D.C.W.)

38044 (AEC-tr-5734(p.255-66)) A SURVEY OF NEUTRON DIFFRACTION INVESTIGATIONS CONDUCTED IN THE NUCLEAR RESEARCH INSTITUTE IN 1960 AND 1961. K. Blinowski, J. Leciejewicz, and J. Sosnowski. (Translation)

A survey of work on elastic nuclear scattering of slow neutrons by solids is presented. The structures of PbO, PbO_2, TeO_2, and WC were investigated as well as the so-called parasitic reflections of neutrons in cyrstal monochromators. (D.C.W.)

38045 (AEC-tr-5734(p.267-9)) INVESTIGATION OF THE SCATTERING OF NEUTRONS BY SOLIDS, CONDUCTED IN THE LABORATORY OF NEUTRON PHYSICS, ATOMIC PHYSICS INSTITUTE, ACADEMY OF THE RUMANIAN PEOPLES REPUBLIC. D. Bally. (Translation)

The influence of crystal structure on the total effective cross section of neutron scattering for Al, As, Se, Sb, and Te at neutron energies of 0.0027 to 0.01 ev was investigated with a neutron crystal spectrometer. The values of the total effective cross sections were more distorted by scattering through small angles when the sample was fine grained. For Al with no texture and large granularity good experimental-theoretical agreement was obtained. The effective cross section of noncoherent scattering for As, Te, and Se were also determined. (D.C.W.)

38046 (AEC-tr-5734(p.270-4)) MAGNETIC TRANSFORMATIONS IN CHROMIUM. R. A. Alikhanov and T. L. Kostina. (Translation)

Experimental data on the temperature dependence of the neutron diffraction, electrical resistance, and magnetic susceptibility of Cr show that Cr possesses two antiferromagnetic phases: an upper phase with a helical structure and a lower phase with the usual antiferromagnetism. The transition point between phases is 120°K, and the resistance and susceptibility show no anomalies around 120°K. The lower phase may have weak ferromagnetism. (D.C.W.)

38047 (AEC-tr-5734(p.275-8)) NEUTRON DIFFRACTION INVESTIGATION OF $Mn_xFe_{3-x}O_4$. Yu. Z. Nozik and I. I. Yamzin. (Translation)

The intensities of neutron diffraction from $Mn_xFe_{3-x}O_4$ monocrystals were measured. The samples were subject to heavy extinction, and the measured intensities of strong reflections were only 0.25 to 0.35 of those calculated. The coefficient of secondary extinction was calculated. A jump in the degree of inversion of the system was observed. (D.C.W.)

38048 (AEC-tr-5734(p.279)) NEUTRONOGRAPHIC INVESTIGATIONS ON Fe–Co–V ALLOYS. K. Kleinstuck. (Translation)

The degrees of ordering in Co–Fe–V alloys with 49-50% Fe, 49-50% Co, and 0-2% V were calculated from the measured intensities of the reflections (100) and (110) and were found to range from 10 to 90%. For alloys without V, a connection exists between the degree of ordering and electrical and magnetic properties. V atoms do not repress ordering in Co–Fe alloys, and property changes are not caused by ordering alone. (D.C.W.)

38049 (AEC-tr-5734(p.280-2)) ABOUT THE INFLUENCE OF TOTAL REFLECTION AND INTENSITY DISTRIBUTION OVER THE CROSS-SECTION OF THE PRIMARY BEAM ON NEUTRON REFLEXES. W. Hase and K. Kleinstuck. (Translation)

The total neutron reflection on the sheets in the Soller collimators and the absorption in cylindrical samples for a varying intensity distribution over the cross section of the monoenergetic primary beam are examined. A correction of total reflection is shown to be unnecessary if relative reflex intensities are calculated, while the error due to inexact absorption correction may be greater than other instrumental errors. (D.C.W.)

38050 (AEC-tr-5734(p.283-4)) NEUTRON DIFFRACTION STUDY OF THE CRYSTAL STRUCTURE OF URANYL NITRATE HEXAHYDRATE. E. S. Makarov and A. A. Melik'yan. (Translation)

Reflexes of two zero-layer lines from two samples were obtained with a neutron diffractometer, and the Fourier syntheses were constructed. Maxima corresponding to the O, N, and H atoms were clearly manifested. The coordinates of the H atoms are given. (auth)

38051 (AEC-tr-5734(p.285)) NEUTRON DIFFRACTION DETERMINATION OF THE POSITION OF HYDROGEN ATOMS IN THE STRUCTURE OF $Li_2SO_4 \cdot H_2O$. L. E. Fykin, N. V. Rannev, and R. P. Ozerov. (Translation)

The positions of H atoms in $Li_2SO_4 \cdot H_2O$ were derived from reflection data. (D.C.W.)

38052 (AEC-tr-5734(p.286-7)) AN INVESTIGATION OF THE DIFFUSION OF NEUTRONS IN WATER AND ICE CLOSE TO 0°C AND ICE AT −80°C. A. V. Antonov, B. V. Granatkin, Yu. A. Merkulev, Ch. K. Smolik, and V. V. Puzanov. (Translation)

The diffusion coefficient and the coefficient of diffusion cooling for H_2O at +0.3°C and ice at −1 and −80°C were measured using a pulsed neutron source method. The results indicate a change in the mechanism of energy transfer from the neutron to the moderator when the H_2O state changes. A decrease in the average cosine of the scattering angle upon transition to ice is also indicated. (D.C.W.)

38053 (AEC-tr-5734(p.288-92)) A STUDY OF THE DIFFUSION OF NEUTRONS IN WATER AND IN ICE AS A FUNCTION OF THE TEMPERATURE BY THE PULSED NEUTRON SOURCE METHOD. Z. Dlouhy and I. Kvitek. (Translation)

The neutron diffusion coefficient, neutron diffusion length, average neutron lifetime before capture, and the diffusion cooling coefficient were measured for H_2O at 0 and 20°C and ice at 0°C. A coefficient M_2 in the relation between the diffusion coefficient and the diffusion cooling coefficient was evaluated. The M_2 values indicate that rotation of the H_2O molecule is completely forbidden and that the translational motion of the molecule is also weakened. (D.C.W.)

38054 (AEC-tr-6009) PROPAGATION OF NEUTRONS IN AN ANNULAR SPACE. J. Brisbois ([France. Commissariat à l'Energie Atomique, Paris]). Translated for Oak Ridge National Lab., Tenn., from report CEA-Note-381. [1962]. 13p.

The thermal and fast neutron fluxes in gaps in a concrete block placed near a reactor core were measured over a length of 2 m using Mn and Ni detectors for the thermal fluxes and (n,p) reactions in Ni and P to detect fast fluxes. The fast and thermal fluxes did not follow a $1/r^2$ law, and the thermal flux attenuation in a 20-mm gap after a 2-m propagation differed by a factor of 10 from that observed in a similar arrangement at Harwell. (D.C.W.)

38055 THE P_∞ POINT-SOURCE SOLUTION OF THE NEUTRON SLOWING-DOWN PROBLEM IN A SPHERE. J. M. Norwood and R. N. Little (Univ. of Texas, Austin). J. Nucl. Energy, Pt. A & B, 17: 245-52(Aug. 1963).

The two-region transport equation is solved in closed form for the neutron distribution arising from a point, monoenergetic, isotropic, source at the center of a spherical body. The body consists of a homogeneous, nonfissionable material surrounded by space. Neutron scattering is assumed elastic and isotropic in the center-of-mass system, and cross sections are assumed independent of energy. The position and energy-dependent solution is attained by the spherical harmonics method without resort to the P_n approximation and is applicable at points inside, on the surface of, and outside the sphere. It applies particularly well to moderators composed of light elements such as carbon or to hydrogenous media. (auth)

38056 SCATTERING OF SLOW NEUTRONS BY CRYSTALS AND LIQUIDS. B. R. A. Nijboer and J. J. J. Kokkedee. Ned. Tijdschr. Natuurk., 29: No. 3, 61-79(1963); No. 4, 93-109(1963). [(In Dutch)]

The dynamic properties of a scattering system seen from theoretical viewpoint are reviewed. The movements of, and the forces between the atoms in crystals or liquids were studied. Details about the scattering of a thermal neutron beam at a single nucleus, the scattering at an ideal single crystal consisting of atoms of one element, and the structure of liquids were given. (RCN)

38057 A VARIATIONAL PROCEDURE FOR CALCULATING FAST GROUP CONSTANTS. P. A. Ombrellaro and F. D. Federighi (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 16: 343-56(Aug. 1963).

A variational procedure for calculating fast energy few group constants is described. For a given medium, the method permits one to express the flux and current solutions of the Boltzmann equation, treated according to P−1 slowing down theory in each group of a few group scheme, as a linear combination of base flux spectra to obtain the group flux and as a linear combination of base current spectra to obtain the group current. The coefficients for combining the base spectra are provided by the theory and depend only on the concentrations of the component elements of the medium. Once the flux and current spectra in each group are calculated, the group constants for the medium can be easily calculated from base flux spectra weighted library microscopic cross sections. Group constants calculated in this manner agree well with those obtained from the MUFT V program. (auth)

38058 SOME PROBLEMS CONCERNING THE THEORY OF PULSED NEUTRON EXPERIMENTS. P. Vértes (Central Research Inst. for Physics, Budapest). Nucl. Sci. Eng., 16: 363-8(Aug. 1963).

Some problems of the theoretical interpretation of pulsed neutron experiments are investigated on the basis of the energy-dependent Boltzmann equation. The relation of the infinite medium theory to the finite medium experiments is discussed in detail. A calculation in P_1L_1 approximation is performed in order to determine the form of neutron flux and the extrapolation length. It is demonstrated that the existence of an asymptotic region is not required to apply the infinite medium theory to the finite medium experiments. (auth)

38059 GREEN'S FUNCTION FOR A BARE SLAB WITH ANISOTROPIC SCATTERING. J. J. McInerney (Pennsylvania State Univ., University Park). Nucl. Sci. Eng., 16: 460-2(Aug. 1963).

The Green's function problem for a bare slab with anisotropic neutron scattering is developed. The one-velocity Boltzmann equation for plane symmetry, with the assumption that the scattering function can be expanded into a finite series of Legendre polynomials, is used in the derivation. (C.E.S.)

38060 INVESTIGATION OF THE INELASTIC SCATTERING OF NEUTRONS IN AN ALLOY OF Ti and Zr. N. A. Chernoplekov, M. G. Zemlyanov, E. G. Brovman, and A. G. Chicherin (Kurchatov Inst. of Atomic Energy, Moscow). Soviet Phys.-Solid State (English Transl.), 5: 78-81(July 1963).

Using a time-of-flight neutron spectrometer, an investigation was made of the inelastic scattering of cold neutrons in a specimen of a disordered alloy of Ti and Zr having a composition corresponding to the zero value of the average amplitude of coherent neutron scattering. A general theory relating the one-phonon incoherent scattering cross section with the frequency spectrum for any crystal is given. On the basis of the results obtained, the phonon spectrum of the two-component disordered system is discussed. (auth)

Nuclear Properties and Reactions

38061 (AE-115) CROSS-SECTION MEASUREMENTS OF THE $^{58}Ni(n,p)^{58}Co$ AND $^{29}Si(n,\alpha)^{26}Mg$ REACTIONS IN THE ENERGY RANGE 2.2 TO 3.8 Mev. J. Konijn and A. Lauber (Aktiebolaget Atomenergi, Stockholm). Aug. 1963. 30p.

The $Si^{29}(n,\alpha)Mg^{26}$ and $Ni^{58}(n,p)Co^{58}$ reaction cross-sections were measured using a surface barrier solid state detector to record the charged particles. Absolute measurements of the neutron flux were made, recording the proton recoils from a thin polyethylene radiator with the solid state detector. Both reaction cross-sections show strong fluctuations as a function of energy, which may be due to the statistical fluctuation of the level densities. Estimations of the level densities of the intermediate nuclei from the relative fluctuations of the cross-section curves are in good agreement with those expected on theoretical grounds. The agreement with earlier measurements of the nickel reaction is good, while absolute values for the cross-sections on the silicon reaction have not been reported before in this energy region. 39 references. (auth)

38062 (AE-117) NEUTRON CROSS SECTIONS FOR ALUMINIUM. Leif Forsberg (Aktiebolaget Atomenergi, Stockholm). Aug. 1963. 33p.

Total, elastic, inelastic, (n,2n), (n,α), (n,p), and (n,γ) cross sections for aluminum were compiled for thermal to 100-Mev neutron energies by a literature search and theoretical interpolations and estimates. Differential elastic cross sections in the center of mass system are represented by the Legendre coefficients. (120 references). (auth)

38063 (IITRI-1193-26) SCINTILLATION SPECTROMETER MEASUREMENTS OF THERMAL NEUTRON CAPTURE GAMMA RAYS FROM NATURAL ELEMENTS. Quarterly Report, May 1, 1963–July 31, 1963. R. C. Greenwood, J. H. Reed, and R. D. Kolar (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Aug. 14, 1963. Contract AT(11-1)-578. 40p.

High energy capture gamma ray spectra were obtained from some twenty elements with the 3 in. × 3 in. NaI(Tl) scintillation detector, and from fifty elements using a 5 in. × 4 in. NaI(Tl) detector. In addition, several low energy capture gamma spectra were obtained with the $1\frac{1}{2}$ in. × 1 in. and the 3 in. × 3 in. NaI(Tl) detectors. Only the low energy prompt gamma ray spectra from natural U, U enriched to 93 percent in U^{235}, U depleted to approximately 350 ppm in U^{235} and Pu containing 97.7 percent Pu^{239} obtained using the $1\frac{1}{2}$ in. × 1 in. NaI(Tl) scintillation detector together with the high energy capture gamma ray spectra from Al, Si, S, Cl, Ni, Dy, W, Re and Hg obtained with the 5 in. × 4 in. NaI(Tl) detector are discussed in detail. (auth)

38064 (JAERI-6013) CHARACTERISTICS OF THE FISSION PRODUCTS. (Japan Atomic Energy Research Inst., Tokyo). 1963. 1p.

The half-lives, beta-particle energies, gamma-ray energies, thermal neutron capture cross sections, and directions of decay are charted for nuclides with Z = 30 to 66. The decay chain yields are also given. (D.C.W.)

38065 (JINR-P-1231) MATERIALY RABOCHEGO SOVESHCHANIYA PO EFFECTU MESSBAUERA, DUBNA, IYUL 3-6, 1962. (Proceedings of the Conference on Mössbauer Effects, Dubna, July 3-6, 1962). (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 194p.

Twenty four papers are included, separate abstracts have been prepared for 14. Seven papers were previously abstracted in NSA. (R.V.J.)

38066 (JINR-P-1231(p.7-16)) TECHNICAL PROBLEMS AND REVIEW OF DATA ON MÖSSBAUER γ TRANSITION. V. P. Alfimenkov and Yu. M. Ostanevich (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

A review is given of data on nuclear emissions and resonance absorption of recoilless γ transition (Mössbauer effect). Preparation of sources, filters, and detectors is discussed, and γ energy shifts and recording systems are analyzed. Comparisons are made of tabulated data for 22 previously studied γ transitions. (R.V.J.)

38067 (JINR-P-1231(p.48-51)) INVESTIGATION OF MÖSSBAUER EFFECT IN W^{182} BY γ–γ COINCIDENCES. Tc. Bonchev, L. Mitrani, S. Ormandzhiev, B. Skorchev, and I. Uzunov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Mössbauer effect in W^{182} was studied by a resonance scattering method instead of the previously used resonance absorption method. The effect was detected by analyzing scattering distributions arising with source temperature variations and by γ–γ coincidences. The results of two series of measurements of relative scattering distributions ($N_{t=-196°C} - N_{t=+20°C}/N_{t=-196°C}$) for source temperature variations from liquid nitrogen to room temperatures were 9.5 ± 3.5%. It is shown that the described installation and γ–γ coincidence method are effective in direct Mössbauer effect detection in W^{182}. (R.V.J.)

38068 (JINR-P-1231(p.52-4)) RESONANCE ABSORPTION OF γ QUANTA WITHOUT RECOIL IN Sm^{149}. V. P. Alfimenkov, Yu. M. Osipovich, T. Ruskov, and A. V. Strelkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Resonance absorption of γ rays at 22.5 kev was studied with a natural samarium oxide source and absorber. Mother nuclei of $Eu_2^{149}O_3$ were added to thin layers (5mg/cm^2) of samarium oxide. The 50 mg/cm^2 absorber was bound to the source by polyvinyl alcohol. Resonance absorption spectra were developed by an ordinary Doppler shift method and by an electromagnetic vibrator. An argon proportional counter recorded γ emissions passing through the absorber. Measurements on the spectrum indicated only one practically shiftless component. The results indicate the resonance parameters are: $\Gamma = (1.53 \pm 0.1) \times 10^7$ ev, $\Delta E = (0.19 \pm 0.12) \times 10^{-7}$ ev, and $E = (10 \pm 1) \times 10^{-2}$, (where Γ is the γ transition width, ΔE the shift between emission and absorption spectra, and E the effect at zero rate with corrections for the background). (R.V.J.)

38069 (JINR-P-1231(p.55-63)) MÖSSBAUER EFFECT IN Sn^{119} NUCLEI AND A SEARCH FOR THE EFFECT IN Pr^{141}. V. A. Bukharev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Gamma resonance absorption in Sn^{119} at 23.8 kev was studied in various tin compounds using a gray tin crystallized into a diamond lattice. An attempt was also made to measure the Mössbauer effect by means of absorption and scattering distribution for the 145-kev emission in Ce^{141} and Pr^{141}. (R.V.J.)

38070 (JINR-P-1231(p.64-5)) OBSERVATION OF MÖSSBAUER EFFECT IN Tb^{159}. I. Dezhi (I. De'zsi) and L. Kostekhili (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Preliminary results are given from measurements of Mössbauer effect in Tb^{159}. The Tb^{159} γ transition at 58 kev was found, and its intensity was determined using irra-

diated gadolinium nitrate. Measurements of γ rays in terbium oxide show the 58-kev line with an intensity magnitude of 1.96 ± 0.3%. Assuming the level half life is 10^{-9} to 10^{-10} sec the width of Tb^{159} 58-kev line is about 100 times larger than that of iron. (R.V.J.)

38071 (JINR-P-1231(p.107-11)) MÖSSBAUER EFFECT AND SEIGNETTOELECTRIC PROPERTIES OF IONIC CRYSTALS. V. Dvorzhak (Dvorak), Ch. Muzikarzh, and V. Yanovets (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Theoretical equations were developed for T_c (Curie temperature). Measurements of Mössbauer effect as a function of temperature near T_c offer important data on the characteristics of anomalous optical branching of certain seignettoelectrics. More detailed calculations are in progress. (R.V.J.)

38072 (JINR-P-1231(p.112)) ON THE THEORY OF TEMPERATURE RED SHIFT OF MÖSSBAUER LINE. Yu. Kagan (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Studies were made of the temperature red shift of Mössbauer lines. The magnitude of the shift (ΔE) in arbitrary multiatomic regular crystals was determined for a full temperature range. The magnitude of the shift was found to be primarily a function of fluctuations of crystal dendrites. A direct relation between ΔE and lattice heat capacity was found only in single-atom crystals. Equations were developed for the shift when the emitter is foreign to the single-atom matrix. The character of temperature dependence was analyzed for the maximum cases: $m'/m < 1$ and $m'/m \gg 1$. It was shown that in a classical concept ΔE is a function of the mass of the emitting nuclei. A general relation between the temperature dependence of shift and the Mössbauer effect at $T \neq 0$ was determined. (tr-auth)

38073 (JINR-P-1231(p.113-14)) EMISSION AND ABSORPTION OF γ QUANTA BY ATOMS WITHOUT RECOIL IN MAGNETIC FIELD. M. V. Kazarnovskii and A. V. Stepanov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Equations were developed for Mössbauer effect when the γ quanta are emitted or absorbed by ionized atom in a strong magnetic field. The quanta are distributed perpendicular to the magnetic lines, and the magnetic moments of the atoms are not equal to zero. (R.V.J.)

38074 (JINR-P-1231(p.115-17)) ON THE ANGULAR CORRELATION IN MÖSSBAUER EFFECT. A. Gelberg (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Angular correlations of cascade γ quanta are ordinarily used for determining nuclear spins. Angular correlation for resonance γ scattering was determined by measuring angular distribution of scattered quanta in relation to the initial distribution. (R.V.J.)

38075 (JINR-P-1231(p.121-32)) ISOMERIC CHEMICAL SHIFTS AND QUADRUPOLE SPLITTING OF γ LINES. V. S. Shpinel (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Gamma resonance absorption by nuclei in solids was studied in order to determine hyperfine γ structure and energy shifts in nuclear interactions with electrostatic fields induced by extra-nuclear charges. Equations were developed for Coulomb interactions and quadrupole nuclear moment interactions with electric field gradients. Effects of interactions on Mössbauer spectra offer new data on nuclei and surrounding nuclear media. (R.V.J.)

38076 (JINR-P-1231(p.133-65)) ON APPLICATIONS OF MÖSSBAUER EFFECT IN CHEMISTRY. V. I. Gol'danskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Applications of Mössbauer effect in chemical studies, perspectives of Mössbauer effect in future research, and data obtained by means of Mössbauer effect are reviewed. A detailed analysis is given of magnetic splitting of iron and tin spectra. (R.V.J.)

38077 (JINR-P-1231(p.167-72)) ANISOTROPIC MÖSSBAUER EFFECT IN β-Sn MONOCRYSTAL. N. E. Alekseev, Tsiu-Hien Fam, V. G. Shapiro, and V. S. Shpinel (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Gamma resonance absorption probability f' at 23.8 kev was investigated in white metallic tin monocrystals. Studies revealed a large anisotropic effect that remained unchanged at 290 to 77°K. Magnitude ratios for f' in various crystals were $f'_{100} : f'_{101} : f'_{001} : f'_{polycryst} = 1 : 0.95 : 0.71 : 0.80$. Variations in maximum absorption and line asymmetries are the result of Sn^{119} excited level quadrupole splitting. (R.V.J.)

38078 (JINR-P-1231(p.173-9)) QUADRUPOLE INTERACTIONS AND ISOMERIC SHIFTS AT 23.8 kev γ TRANSITION OF Sn^{119} NUCLEI IN TIN–ORGANIC COMPOUNDS. A. Yu. Aleksandrov, N. I. Delyagin, K. P. Mitrofanov, L. S. Polak, and V. S. Shpinel (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Resonance absorption spectra of tetravalent SnX_4 and organic tin compounds $(C_4H_9)_2SnX_n$ (where X is an element or a group of atoms and n = 1 or 2) were investigated. Data on isomer shifts δ and quadrupole splitting Δ are tabulated, and a diagram of resonance absorption spectra for $(C_4H_9)_2SnX_2$ (where X is a halogen) are included. Both the δ and Δ are expressed in 10^{-8} ev. (R.V.J.)

38079 (JINR-P-1231(p.181-3)) ON THE γ QUANTA RESONANCE ABSORPTION SPECTRA AS A FUNCTION OF CRYSTAL TEMPERATURE. Tsui-Hieng Fang and V. S. Shpinel (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). (In Russian)

Gamma resonance absorption spectra at 23.8 kev were studied using Sn^{119}. Polycrystalline tin oxide (SnO_2) powder was used as source and absorber. Measured spectral half-widths as functions of filter thickness (from 4.5 to 20.5 mg/cm^2) and temperature (78, 293, 495, and 645°K) were analyzed. A considerable expansion of half-width was observed at elevated temperatures. The linear shift dependence on temperature was confirmed, and the curve gradient was determined as $(3.5 \pm 0.2) \times 10^{-4}$, in agreement with $\Delta E_\gamma = \frac{3}{2}(kT/m_n c) = 3.50 \times 10^{-4}$ T (mm/sec). (R.V.J.)

38080 (JINR-P-1273) IZUCHENIE REAKTSII PEREDACHI DVUKH NEITRONOV PRI OBLUCHENII IZOTOPOV ZIRKONIYA Zr^{90}, Zr^{92}, I Zr^{94} IONAMI N^{15}. (Some Investigations of Two-Neutrons Transfer Reactions in Bombardment of Isotopes Ar^{90}, Zr^{92}, and Zr^{94} with N^{15} Ions). V. V. Volkov, L. Pomorski, Ya. Tys, and Ya. Vil'chinski (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1963. 12p.

The Zr^{90}, Zr^{92}, and Zr^{94} separated isotope targets were bombarded with N^{15} ions to investigate the dependence of the probability of two-neutron transfer on the nuclear structure. Effective cross sections were measured by means of the delayed neutron activity of N^{17} nuclei in the bombarding ion energy interval 70 to 120 Mev. The ratios of the cross sections for the two-neutron transfer from Zr^{94}, Zr^{92}, Zr^{90}

to N^{15}, were 17:6:1 and 6:4:1 for N^{15} ions at 60 and 100 Mev (in C.M.S.) respectively. (auth)

38081 (JINR-P-1286) ISSLEDOVANIE POGLOSHCHENIYA π^+ I π^--MEZONOV PRI ENERGII 40-70 Mev V YADRAKH UGLERODA S POMOSHCH'YU PROPANOVOI PUZYR'KOVOI KAMERY. (Investigation of Pion Absorption by Carbon Nuclei at 40-70 Mev by Means of a Propane Bubble Chamber). M. P. Balandin, O. I. Ivanov, V. A. Moiseenko, and G. L. Sokolov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 25p.

The absorption of meson (π^+) of equal energy by C nuclei was studied. The total cross sections for π^+ and π^- absorption and charge exchange were found to be 98×10^{-27} and 99×10^{-27} cm^2, respectively. The angular distribution of charged particles with respect to the incident meson direction proved to be isotropic in meson (π^-) absorption and anisotropic in meson (π^+) absorption. The distributions of absorption events indicate that absorption occurs only in nucleon pairs. The parameter η that determines the probability of π^+ absorption in neutron-proton pairs was found to be 0.65 ± 0.10. (auth)

38082 (JINR-P-1291) REAKTSII PEREDACHI AL'FACHASTITS PRI STOLKNOVENII SLOZHNYKH YADER. (Alpha Particle Transfer Reactions in Collision of Nuclei). V. K. Lukyanov and I. Zh. Petkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 14p.

A model is suggested for explaining the angular and energy distributions of alpha particles observed in collisions of nuclei of the alpha particle type with heavy nuclei. The character of the link of alpha particles in an incident nucleus plays a decisive role in the mechanism of the process. The model accounts for the available experiments on the angular and energy distribution. (auth)

38083 (JINR-P-1299) OBRAZOVANIE SPONTANNOGO DELYASHCHEGOSYA IZOMERA V REAKTSIYAKH S α-CHASTITSAMI I DEITERONAMI. (The Formation of a Spontaneously Fissioning Isomer in Reactions with α-Particles and Deuterons). G. N. Flerov, S. M. Polikanov, K. A. Gavrilov, V. L. Mikheev, V. P. Perelygin, and A. A. Pleve (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1963. 6p.

The formation of a spontaneously fissioning isomer previously discovered in heavy ion (O,Ne) reactions was observed while bombarding plutonium and americium targets by He^4 and deuterium ions. It is concluded that the spontaneously fissioning nucleus has atomic number $Z \leq 95$ and mass number $A \leq 242$. (auth)

38084 (JINR-P-1303) GAMMA PEREKHODY V DEFORMIROVANNYKH YADRAKH S UCHETOM PARNYKH KORRELYATSII. (Gamma-Transitions in Deformed Nuclei with Account of Pairing Correlations). N. I. Pyatov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 7p.

The reduced probabilities of E1 and M2 transitions in deformed nuclei were analyzed taking into account the pairing correlations. The results obtained point to the essential hindrance of the E1 transitions when $\Delta K = 1$ and $\Delta \Sigma = 1$. The possibility of analyzing the γ-transitions from the two-quasi-particle levels in even-even nuclei by means of the data on odd nuclei is shown. (auth)

38085 (KAPL-M-DTG-2) A REVIEW OF EXISTING DATA ON THE THERMAL CROSS SECTION AND RESONANCE INTEGRAL OF PROTACTINIUM^{233}. D. T. Goldman and W. E. Moore (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 21, 1963. Contract W-31-109-eng-52. 15p.

An analysis of available experimental data on neutron capture by Pa^{233} suggests that the following are preferred values for the thermal cross section and resonance integral, respectively: 48 ± 5 and 920 ± 90 barns. A scheme for preparing a fast cross section library for Pa^{233} is also suggested. (D.C.W.)

38086 (NP-13086) RESOLVING COMPLEX DECAY CURVES. Research Note RN-123. R. Cambria and M. Zizza (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Feb. 1960. 10p.

If two or more radioactive isotopes emitting almost the same energy gamma ray are present in one radioactive sample, then the resulting decay curve for that energy gamma is a complex one consisting of components from each isotope. A least squares method is derived for resolving the complex decay curves to obtain the initial activity of each element in the radioactive sample. In addition to the regular derivation, the method is also presented in matrix form. (auth)

38087 (NYO-10034) A COMPARISON OF THE $C^{12}(He^3,p)$ AND (He^3,n) REACTIONS LEADING TO ANALOG STATES IN N^{14} AND O^{14}. H. W. Fulbright, W. Parker Alford, O. M. Bilaniuk, V. K. Deshpande, and J. W. Verba (Rochester, N. Y. Univ.). Feb. 5, 1962. Contract AT (30-1)-875. 20p.

Angular distributions and excitation functions were measured for the $C^{12}(He^3,n)O^{14}$ (ground state) and the $C^{12}(He^3,p)N^{14}$ (1st ex. st.) reactions at energies between 6.5 and 11 Mev. Angular distributions of both protons and neutrons show strong forward peaking at all energies. At small angles the data can be fitted with the predictions of a simple plane-wave direct-interaction theory using a fixed value of R = 5.0 f. At larger angles the measured differential cross sections are bigger than those predicted by the simple theory although they are mostly much smaller than the 0° cross sections observed at the same energies. Excitation curves were obtained at 10° by the simultaneous measurement of the yields of neutrons and protons from the same target. A strong energy dependence was observed in each case. The ratio $(d\sigma n/d\sigma p)_{10°}$ was found to be nearly constant at the value 2 over the entire energy range. The same ratio is given by the isotopic spin factor for the reaction, but what significance should be attributed to the agreement is not completely clear. It was concluded that the reactions proceed mostly through a direct-interaction process, but that the simple plane-wave form of the theory is insufficient to account for all the results. (auth)

38088 (ORNL-3493) TABLES OF CLASSICAL SCATTERING INTEGRALS FOR THE BOHR, BORN-MAYER, AND THOMAS-FERMI POTENTIALS. Mark T. Robinson (Oak Ridge National Lab., Tenn.). Sept. 23, 1963. Contract W-7405-eng-26. 67p.

Values of the distance of closest approach, the center-of-mass scattering angle, and the time integral are tabulated as functions of the impact parameter and the relative kinetic energy for each of three repulsive potentials. The classical theory of scattering was used as the basis for the calculations. The potentials used are the Born-Mayer (exponential), the Bohr (exponentially screened Coulomb), and the Thomas-Fermi. (auth)

38089 (TID-17643) PROTON WIDTHS IN A DIFFUSE WELL. J. P. Schiffer (Argonne National Lab., Ill.). Oct. 1962. Contract [W-31-109-eng-38]. 12p. (UAC-7009)

Widths were calculated for resonant scattering of protons by a Woods-Saxon potential with accepted parameters. It is found that the single-particle estimate is only about a quarter to a half of the Wigner-Teichman estimate for a radius of about 1.5 $A^{1/3}$ F. (auth)

38090 (TID-17663) DEPENDENCE OF FISSION FRAGMENT KINETIC ENERGIES AND NEUTRON YIELDS ON NUCLEAR STRUCTURE. R. Vandenbosch (Copenhagen. Universitet. Institut for Teoretisk Fysik and Argonne National Lab., Ill.). Sept. 1962. Contract [W-31-109-eng-38]. 27p. (UAC-6965)

It is suggested that the dip in kinetic energy and the sawtooth structure in the prompt neutron yields for thermal neutron fission of U^{235} result from the influence of the shell structure of the eventual fragments on the deformations at the scission configuration. A simple model embodying this assumption was explored in order to clarify the effects involved. Fragments that have a closed shell structure prefer to retain a spherical shape at the scission configuration, whereas fragments which are soft with respect to deformation are more distorted at the scission configuration. From such a model, it is seen how rather modest variations in the deformation energy as a function of distortion are exploited by the Coulomb repulsion between the eventual fragments to produce much larger effects on kinetic energies and neutron yields. This model, utilizing parameters determined from the U^{235} experimental data, accounts for the qualitative features of the kinetic energy release and neutron yields for other fissioning nuclei from Bi to Cf. It is concluded that the structure in the kinetic energy release and neutron yields is primarily related to the shell structure of the final fragments rather than to differences associated with hypothetical symmetric and asymmetric modes. The large deficit in kinetic energy observed for U^{235} near symmetry is attributed to the fact that both of the neutron-rich primary fission fragments for these mass divisions lie in a region characterized by an unusually low resistance towards deformation. 28 references. (auth)

38091 (TID-19350) LOW ENERGY NUCLEAR PHYSICS. Report 807-4. Annual Report No. 4, August 1, 1960–July 31, 1961. Philip S. Jastram (Ohio State Univ. Research Foundation, Columbus). Aug. 31, 1961. Contract AT(11-1)-605. 126p.

The design, operation, performance, and theory of an automatically balancing and recording a-c bridge are reported. The lifetimes of certain excited states of Sb^{121} were studied by the fast-slow gamma coincidence technique. The results confirm Gupta's results on the coincidences and agree with his Te^{121} decay scheme. The 576 and 506-kev gamma rays were found to have half lives $< 1.5 \times 10^{-9}$ sec, while the 70-kev gamma ray has a half life of $(8 \pm 1.5) \times 10^{-9}$ sec. Spins and parities were assigned to the Sb^{121} states, assuming the validity of the shell model. An analysis of data on the K-conversion coefficients of pure E2 transitions of the type $0^+ - 2^+$ in even-even nuclei indicated that the dependence of the coefficients on the nuclear deformation may be real. An analysis of l-forbidden M1 transitions was also carried out. The limits of applicability of the sum-coincidence technique for determining the total conversion coefficients of gamma rays were investigated. The coefficient (1.9) computed for the 79-kev transition in coincidence with the 358-kev gamma ray in Ba^{133} decay agrees well with the value for a predominantly M1 transition. The level scheme of Mg^{26} was obtained by a study of the gamma spectrum from Al^{26} decay. No 0.707-Mev gamma was observed, and the results indicate a spin of 2 or 3 for the 2.95 Mev level. (D.C.W.)

38092 (TID-19385) SEARCH FOR A LONG LIVED H^4. B. M. K. Nefkens and G. Moscati (Illinois. Univ., Urbana). 1963. Contract AT(11-1)-1195. 28p.

A search was made for the β decay of a long-lived H^4, produced by 250-Mev bremsstrahlung in natural Li. No evidence for such a long lived isotope is found. The following upper limits for the production cross section were obtained: $\sigma_p < 6.7 \times 10^{-4}$ μb, assuming that the half life of H^4 is 3 min and $\sigma_p < 2.3 \times 10^{-4}$ μb, assuming the half life is 1000 min. The β detector was also sensitive to gamma rays, but no evidence for delayed gamma rays was found. (auth)

38093 (UCRL-7129) GAMMA YIELD FROM PROTON CAPTURE ON B^{11}. C. C. Gardner, J. D. Anderson, and C. Wong (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 8, 1962. Contract W-7405-eng-48. 13p.

The 90° yield of capture gamma rays leading to the ground and first excited states of C^{12} was measured in the proton energy range 6.8–14.0 Mev. This overlaps previous data and includes the peak of the giant dipole resonance corresponding to transitions to the first excited state of C^{12}. Assuming an isotropic angular distribution, the cross section at the peak of the yield for the ground state gamma transition (γ_0) is 1.75×10^{-28} cm^2. The peak in the first excited state yield (γ_1) occurs at 25.5 ± 0.2 Mev excitation with a width at half maximum of 4.5 Mev. The peak cross section for γ_1, assuming an isotropic angular distribution, is 1.35×10^{-28} cm^2. The hypothesis of a giant resonance in γ_1 at an energy above that for γ_0 approximately equal to the energy of the first excited state was confirmed. (auth)

38094 (UCRL-10850) THE EFFECT OF ANGULAR MOMENTUM OF THE COMPOUND NUCLEUS ON THE RATIO OF THE ISOMERS Te^{119} AND Te^{119m} PRODUCED IN LOW-ENERGY BOMBARDMENTS (thesis). David W. Seegmiller (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). Aug. 1963. Contract W-7405-eng-48. 206p.

The effect of angular momentum on compound nucleus reactions was investigated by measuring the formation cross-section ratios of a pair of isomers produced through compound nuclei—xn reactions. Five different projectiles were used to produce the compound nucleus Te^{122*}, which yielded the isomers of Te^{119} through a 3n reaction. The projectiles ranged in size from He^3 to O^{18}. The same isomers were also produced through 2n and 4n reactions by bombardment of the appropriate tin isotopes with He^3 and He^4. A method involving separation of the antimony daughter was devised for determining the isomer ratios. This method was completely independent of any decay scheme. The experimentally determined ratios (upper-state to lower-state isomer) varied from a low of about 0.75 to a high of about 25. The expected increase of ratio with energy and projectile size was verified. An apparent direct interaction of Li^7 projectiles was observed. Excitation functions were obtained for the reactions proceeding through the Te^{122*} compound nucleus. The expected shift in peak position with projectile size was clearly demonstrated. Compound-nucleus calculations were performed by assuming a rounded nuclear potential approximated by a parabola (Bunthorne). Good agreement was obtained between experimentally determined isomer ratios and predictions based upon the calculated average angular momentum of the compound nucleus. 96 references. (auth)

38095 (AEC-tr-5981) THEORY OF ENERGY TRANSFER IN COLLISIONS. PART III. L. Landau and E. Lifschitz. Translated by Lydia Venters (Argonne National Lab., Ill.) from Zh. Eksperim. i Teor. Fiz., 18: 750-8 (1948). 12p.

A method that allows precise calculation of the effective cross section of the splitting of a deuteron into neutron and proton while flowing in the Coulomb field is derived. The energy distribution of the emerging particles as well as their angular distribution have been determined. (auth)

38096 MEASUREMENT OF THE BETA SPECTRUM OF Na^{24}. H. Paul, F. P. Viehboeck, P. Skarek, H. Baier, I. Hofmann, and H. Wotke (Österreichische Studiengesellschaft für Atomenergie, GmbH, Vienna). Acta Phys. Austriaca, 16: 278-83(1963). (In German)

The intermediate image beta spectrometer and the scintillation detector used in a new measurement of the β spectrum of Na^{24} were described briefly. The shape factor was determined with two Na^{24} sources. The variations between the two were attributed to the source carrier and the distance of the source from the pole shoe. Negative a coefficients were found in the energy range > 250 kev. The results, however, gave no clear decision between previous discrepant values. (J.S.R.)

38097 EVALUATION OF COINCIDENCE MEASUREMENTS OF COMPLICATED SPECTRA. E. Ujlaki (Universität, Vienna). Acta Phys. Austriaca, 16: 289-95 (1963). (In German)

In complicated spectra it is not possible to say directly from a measurement whether and with what intensities one line is in coincidence with another line. The effect of the Compton distribution and the various intensities of the lines makes a clear decision impossible in many cases. The different effects on a general spectrum were studied. It was shown that the only significant factor is the indication of the coincidence degree. The "coincidence probability" was defined and a method for its measurement was given. (tr-auth)

38098 LEVEL ANALYSIS IN RESONANT FISSION. O. Hittmair. Acta Phys. Austriaca, 16: 324-6(1963). (In German)

The formula for the angular distribution of the products of resonant fission is given and applied to the resonant fission of Th^{232} with 1.60-Mev neutrons. There is good agreement between theory and experiment on the assumption of a $^3/_2-$ and a $^1/_2+$ band at the saddle point. Actually, for A = 233 (143 neutrons) the state is $^3/_2-$ (501) with adjacent states $^1/_2+$ (631) and $^{13}/_2+$ (606). (J.S.R.)

38099 JACOBI COORDINATES IN THE FORMAL RESONANCE THEORY. Peter Kasperkovitz (Technische Hochschule, Vienna). Acta Phys. Austriaca, 16: 359-61 (1963). (In German)

In the formal resonance theory, it is usual to consider stationary nuclear reactions in the configuration space. A distinction is made between an inner region, which corresponds to the totality of all situations in which there are interactions between each nucleon pair, and an external region in which only a part of the short-range interactions must be considered. It is satisfactory on the particle surface whose totality forms the limits between both regions to introduce Jacobi coordinates as surface variables. The conditions are illustrated with a simple example. The implications with respect to the surface elements and boundary conditions are discussed. (J.S.R.)

38100 NEUTRON SEPARATION ENERGIES FOR TELLURIUM AND THE $I^{130}-Te^{130}$ AND $Te^{123}-Sb^{123}$ DECAY ENERGIES. R. C. Barber, W. McLatchie, R. L. Bishop, P. Van Rookhuyzen, and H. E. Duckworth (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 41: 1482-8(Sept. 1963).

Values derived from mass spectral doublets are reported for the following mass differences: $Te^{124}-Te^{122}$, $Te^{125}-Te^{123}$, $Te^{126}-Te^{124}$, $Te^{128}-Te^{126}$, and $Te^{130}-Te^{128}$. The double neutron separation energies for Te^{124}, Te^{126}, Te^{128}, and Te^{130} are found to exhibit a strikingly regular behavior. Single neutron separation energies are calculated for Te^{123} to Te^{130} inclusive and total decay energies are deduced for the $I^{130}-Te^{130}$ and $Te^{123}-Sb^{123}$ transitions. (auth)

38101 PREDICTIONS OF THE ASYMMETRIC ROTATOR MODEL AND THE GAMMA-VIBRATION MODEL FOR GAMMA-RAY TRANSITION RATIOS. M. A. Preston and D. Kiang (McMaster Univ., Hamilton, Ont. and Dalhouse Univ., Halifax, Nova Scotia). Can. J. Phys., 41: 1531(Sept. 1963).

The predictions of the asymmetric-rotator and unified nuclear models as to the relative intensities of the gamma lines of Er^{166} are compared with one another and with experimental values. It is found that both models describe the spectrum about equally well. (T.F.H.)

38102 SYSTEMATICS GOVERNING DOUBLE NEUTRON SEPARATION ENERGIES BETWEEN THE 50 AND 82 NEUTRON SHELLS. R. L. Bishop, R. C. Barber, W. McLatchie, J. D. MacDougall, P. Van Rookhuyzen, and H. E. Duckworth (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 41: 1532-4(Sept. 1963).

The double neutron separation energies of even-mass-number nuclides of Zr, Sn, Te, Cd, Mo, and Xe are found by mass-spectrometric measurements. The systematics of the separation energies are studied by plotting the separation energy as a function of neutron number N. (T.F.H.)

38103 SOME CHARACTERISTICS OF THE FORMATION OF LITHIUM-8 BY THE INTERACTION OF 660-Mev PROTONS WITH $_6C^{12}$ NUCLEI. O. V. Lozhkin, N. A. Perfilov, and Yu. P. Yakovlev. Dokl. Akad. Nauk SSSR, 151: 826-8(Aug. 1, 1963). (In Russian)

Formation of fast particles carrying multiple charges by the splitting of light nuclei by high-energy protons is of great interest for the theory of direct interactions; therefore, the angular distribution and the energy spectra of $_3Li^8$ fragments, emitted at various angles with respect to the incident protons were investigated for the case involving the splitting of the $_6C^{12}$ nucleus. Thin polystyrene and polyethylene films were exposed in a vacuum chamber to a 10^{13} cm^{-2} proton flux in the extracted beam of the Joint Institute for Nuclear Studies phasotron, using a proton energy of 660 Mev. The Li^8 fragments were recorded by means of a low-sensitivity nuclear emulsion in the angular range from 20 to 160°. Results revealed the formation of T-shaped tracks which in principle could be formed by $_3Li^8$, $_3Li^9$, and $_5B^8$ nuclei at 20, 47, 90, and 137°. They were due mostly to $_3Li^8$ and to a slight degree to $_3Li^9$, the isobar $_5B^8$ was absent. This indicated a substantially asymmetric structure of $_6C^{12}$ in relation with the mirror symmetry of the $_5B^8$ and $_3Li^8$ cluster. While this supports the assumption that the incident protons split the clusters quasi-elastically, it is contradicted by the energy measurements as a function of the angle of observation and the energy of the incident particles. It was concluded that the softest portion of the $_3Li^8$ spectrum is due to the formation by an (n,2n) reaction of an intermediate $_4Be^9$ particle and to the decay of the residual nucleus. (TTT)

38104 THE MAGNETIC MOMENTS OF Xe^{129} AND Xe^{131}. D. Brinkmann (Universität, Zurich). Helv. Phys. Acta, 36: 413-14(1963). (In German)

The magnetic moments of Xe^{129} and Xe^{131} were remeasured by the nuclear magnetic resonance technique in gaseous samples to correct for an observed pressure dependent resonance frequency shift. Extrapolated to zero density the results are: $\mu(Xe^{129}) = (-0.772472 \pm 0.000012)$ n.m., $\mu(Xe^{131}) = (+0.686966 \pm 0.000009)$ n.m. (auth)

38105 BETA-GAMMA DIRECTIONAL ANGULAR CORRELATIONS FOR THE DECAY OF Sb^{124}, Eu^{152}, AND Eu^{154}. Jules-Willy Sunier (Laboratoire de Physique des Hautes Energies, E.P.F., Zurich). Helv. Phys. Acta, 36: 429-57 (1963). (In French)

The β-γ directional correlations involving the first-forbidden beta transitions at 2.31, 1.48, and 1.84 Mev in the decay of Sb^{124}, Eu^{152}, and Eu^{154} were measured as a function of beta energy. Near maximum beta energy the anisotropy factor $\epsilon(W)$ in the correlation function $N(W,\theta) = 1 + \epsilon(W)\, P_2(\cos\theta)$ was found to be $\epsilon(4.74\ m_e c^2) = -0.387 \pm 0.012$, $\epsilon(3.64) = -0.447 \pm 0.013$ and $\epsilon(4.33) = -0.315 \pm 0.034$ for Sb^{124}, Eu^{152}, and Eu^{154}, respectively. The absence of a term $P_4(\cos\theta)$ in the β-γ correlation functions provided further evidence for the first-forbidden character of the involved beta transitions. Pure $\int B_{ij}$ transitions were excluded from the experimental values of $\epsilon(W)$ but the data implied that this matrix element must contribute very significantly. The nuclear matrix elements involved in the observed beta transitions were computed from the measured values of $\epsilon(W)$ and by taking into account the experimental data of the shape correction factors and of the β-γ (circularly polarized) angular correlations. The results are characterized by the predominance of the $\int B_{ij}$ matrix element and yield for Sb^{124}, Eu^{152}, and Eu^{154} respectively: $|\int B_{ij}/R| = (1.76 \pm 0.22) \times 10^{-2}$, $(2.86 \pm 0.36) \times 10^{-3}$, $(1.20 \pm 0.14) \times 10^{-3}$; $|\int r/R| = (1.7 \pm 1.1) \times 10^{-3}$, $(5.5 \pm 3.0) \times 10^{-4}$, $(0.5 \pm 1.5) \times 10^{-4}$; $|\int i\sigma \times r/R| = (1.4 \pm 1.4) \times 10^{-3}$, $(0.97 \pm 1.70) \times 10^{-4}$, $(2.3 \pm 1.4) \times 10^{-4}$; and $|\int i\alpha| = (1.43 \pm 0.77) \times 10^{-4}$, $(1.97 \pm 0.82) \times 10^{-4}$, $(0.73 \pm 0.50) \times 10^{-4}$. R is the nuclear radius in units $h = m_e = c = 1$. Selection rules suppressing the matrix elements other than $\int B_{ij}$ are discussed. The results are compared with the predictions of the Conserved Vector Current Theory. (auth)

38106 THE REACTIONS $Li^6(d,p)Li^7$ AND $Li^6(d,\alpha)\alpha$ AT DEUTERON ENERGIES OF 3 TO 5 Mev. V. Meyer, W. Pfeifer, and H. H. Staub (Universität, Zurich). Helv. Phys. Acta, 36: 465-72(1963). (In German)

The reactions $Li^6(d,p)Li^7$ to the ground state, the first excited state at 0.478 Mev, and the second excited state at 4.63 Mev in Li^7 were studied at deuteron energies between 3.4 and 5.2 Mev. Reduced widths were obtained for the first two reactions. The transition to the 4.63-Mev level in Li^7 showed no stripping behavior as was to be expected if this level is the $^7/_2^-$ member of the F^{22} doublet in Li^7. In addition the $Li^6(d,\alpha)\alpha$ reaction was studied in the same energy interval. A 2^+-level in Be^8 was found at an excitation energy of 25 Mev in Be^8. (auth)

38107 OBSERVATION OF THE NUCLEAR RESONANCE IN FERROMAGNETIC IRON TO 65,000 ATMOSPHERES. J. D. Litster and G. B. Benedek (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 34: 688-9 (Mar. 1963).

Measurements were made of the pressure dependence of the Fe^{57} nuclear resonance frequency (ν) in ferromagnetic iron to 65 kbars using AgCl as a solid pressure transmitting medium in a belt-type press. ν varies linearly with pressure with $(\partial\nu/\partial P)_{T=25.5°C} = -7.67 \pm 0.22$ (kc/kbar). Absence of substantial line broadening above 15 kbars indicates that the pressure in our sample was essentially hydrostatic. (auth)

38108 ISOMERIC YIELD RATIOS OF ^{44}Sc PRODUCED BY THE ^{14}N BOMBARDMENT OF ^{32}S AND ^{31}P. M. E. Wetzen (Univ. of Tennessee, Knoxville) and K. S. Toth. J. Inorg. Nucl. Chem., 25: 1073-7(Sept. 1963). (In English)

Thick targets of red phosphorus and zinc sulfide were bombarded with 27.5 Mev N^{14} ions accelerated in the Oak Ridge 63-in. Cyclotron. Cross sections, as a function of the bombarding energy, were measured for the production of Sc^{43}, Sc^{44m}, and Sc^{44g} from P^{31} and S^{32}. The irradiated materials were γ-counted, and the radioactive products were identified by their characteristic γ rays and half lives. From the cross sections, the isomeric yield ratios of Sc^{44m}/Sc^{44g} were found. For P^{31} the isomer ratio varied from 0.68 at 23.5 Mev to 1.68 at 27.0 Mev, while for S^{32} it varied from 0.12 at 20.5 Mev to 1.15 at 27.0 Mev. This increase in the ratio for both reactions is consistent with a compound nucleus formation mechanism for Sc^{44} at all energies considered. Accordingly, the higher ratio in the phosphorus reaction than in the sulfur reaction may be attributed to the smaller amount of angular momentum taken off by the single proton emitted from the P^{31} reaction than by the two protons emitted in the S^{32} case. (auth)

38109 DECAY OF ^{131}Ba–^{131}Cs. W. S. Lyon (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 25: 1079-83(Sept. 1963). (In English)

The absolute intensities of eight γ rays emitted following electron capture in Ba^{131} were determined: 0.130 Mev (0.28), 0.220 Mev (0.28), 0.380 Mev (0.16), 0.496 Mev (0.60), 0.600 Mev (0.032), 0.820 Mev (0.0034), 0.910 Mev (0.0009), and 1.04 Mev (0.017). The method used was to prepare Ba^{131} free from its Cs^{131} daughter, allow the Cs^{131} activity to grow in, separate the Cs^{131} activity from the parent and measure its activity, measure the γ activity of the Ba^{131} by γ spectrometry, and calculate the absolute amount of Ba^{131} from parent daughter growth relationships. The half life of Cs^{131} was determined to be 9.83 ± 0.28 days. The ratio of the pile neutron activation cross-sections for the production of Ba^{131} and Ba^{133} was found to be $\sigma_{130}/\sigma_{132} = 1.36 \pm 0.08$. (auth)

38110 DISCOVERY OF A NEW FERMIUM ISOTOPE. R. C. Gatti, R. Brandt, L. Phillips, and S. G. Thompson (Univ. of California, Berkeley). J. Inorg. Nucl. Chem., 25: 1089-91(Sept. 1963). (UCRL-10456). (In English)

A spontaneous-fission activity was observed in a fermium fraction separated from 120 mg of mixed curium isotopes which was subjected to an integrated flux of 2.4×10^{22} neutrons per cm^2 at the Materials Testing Reactor. A least-squares analysis of the spontaneous-fission decay data yielded a half life of 10.8 days with a standard deviation of about (+2.2/−1.8) days. An estimated half life of (11 +10/−6) days is reported. The mass assignment is uncertain, but limited to A = 258 or 257. (auth)

38111 HALF-LIVES OF SOME RARE EARTH NUCLIDES. D. C. Hoffman (Los Alamos Scientific Lab., N. Mex.). J. Inorg. Nucl. Chem., 25: 1196-8(Sept. 1963). (LADC-5729). (In English)

Measurements were made of the half lives of Y^{91}, Pr^{143}, Pr^{144}, Nd^{147}, Pm^{149}, Pm^{151}, Sm^{153}, Gd^{153}, Th^{160}, Tb^{161}, Dy^{159}, Dy^{166}, and Ho^{166}. (M.C.G.)

38112 COMPUTATION OF MATRIX ELEMENTS OF INTEGRABLE NUCLEAR TWO-PARTICLE INTERACTION OPERATORS. R. K. Nesbet (Brookhaven National Lab., Upton, N. Y.). J. Math. Phys. (N. Y.), 4: 1262-71 (Oct. 1963). (BNL-6833)

A general procedure is described for computing matrix elements of operators that occur in a realistic nuclear

Schrödinger hamiltonian, in a basis of orbitals with radial factors of the form $N_a r^{2n_a+l_a} \exp(-\gamma_a r^2)$, where n_a is an arbitrary nonnegative integer and γ_a is an arbitrary positive number. The specific operator forms considered are those present in the asymptotic one-pion exchange potential, except that the functional forms of the potentials V(r) are not prescribed beyond the requirement that they should be integrable. (auth)

38113 REDUCED WIDTH AMPLITUDE DISTRIBUTIONS AND RANDOM SIGN RULES IN R-MATRIX THEORY. T. J. Krieger and C. E. Porter (Brookhaven National Lab., Upton, N. Y.). J. Math. Phys. (N. Y.), 4: 1272-9(Oct. 1963). (BNL-6759)

A multivariate reduced width amplitude distribution is derived from quite general assumptions of level independence and of functional form invariance of the distribution. The multivariate distribution reduces to the well-known Gaussian singlet distribution (one degree of freedom) and moreover allows for the possibility of channel-channel reduced width amplitude correlations. The multivariate distribution is used as a basis for a more precise statement of the "random sign" rules of R-matrix theory than hitherto given. It is pointed out that these rules imply a linear averaging over the multivariate reduced width amplitude distribution (in addition to the usual linear energy average) and are not merely consequences of the equiprobability of positive and negative signs for the reduced width amplitudes. The influence of the energy eigenvalue distribution and of variable reduced width amplitude statistics is discussed. The multivariate reduced width amplitude distribution is relevant to any reaction theory in which level widths are defined. (auth)

38114 REDUCED WIDTH AMPLITUDE DISTRIBUTIONS FOR THE UNITARY ENSEMBLE. Nazakat Ullah (Brookhaven National Lab., Upton, N. Y.). J. Math. Phys. (N. Y.), 4: 1279-82(Oct. 1963). (BNL-6917)

The reduced width amplitude distributions for a system not invariant under time reversal (unitary ensemble) are derived. The form of the joint distribution function is compared with that of the orthogonal ensemble. The calculation of the reduced width channel-channel correlation coefficient shows that only a positive width correlation is possible. (auth)

38115 THE CROSS SECTION OF THE REACTION ^{6}Li(n,p)^{6}He IN THE NEUTRON ENERGY RANGE 3.5 TO 14.8 Mev. J. F. Barry (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. A & B, 17: 273-5(Aug. 1963).

The cross section of the $Li^6(n,p)He^6$ reaction was determined by an activation method. The cross section was found to rise sharply from a threshold of about 3.5 Mev to a value of about 18 mb at 6 Mev, subsequently falling to 7 mb at 15 Mev. The cross section at 14.8 Mev is in agreement with that found by other workers at this neutron energy. A value of 14 ± 1.5 mb for the $Li^7(n,d)He^6$ reaction cross section at 14.8 Mev was also measured during these experiments. (auth)

38116 EXPERIMENTAL DETERMINATION OF THE EFFECTIVE THRESHOLD ENERGY OF SOME REACTIONS. R. Nilsson (Aktiebolaget Atomenergi, Studsvik, Sweden). J. Nucl. Energy, Pt. A & B, 17: 279-80(Aug. 1963).

Various kinds of foils were activated in the water outside the core of the reactor R2-0 at a distance of 1 and 31 cm. The total fission neutron flux (ϕ_f) and the effective threshold energy (E_{eff}) of the resulting reactions are tabulated for $In^{115}(n,n')In^{115m}$, $S^{32}(n,p)P^{32}$, $P^{31}(n,p)Si^{31}$, $Ni^{58}(n,p)Co^{58}$, $Ti^{46}(n,p)Sc^{46}$, $Cu^{63}(n,\alpha)Co^{60}$, and $Al^{27}(n,\alpha)Na^{24}$. (L.T.W.)

38117 $^3S_1$ HYPERFINE-STRUCTURE SEPARATIONS AND ISOTOPE SHIFTS OF RADIOACTIVE Cd^{107}, Cd^{109}, AND OF STABLE Cd ISOTOPES. R. J. Hull and H. H. Stroke (Massachusetts Inst. of Tech., Cambridge). J. Opt. Soc. Am., 53: 1147-52(Oct. 1963).

High-resolution spectra of radioactive Cd^{107} and Cd^{109}, and of Cd^{111} and Cd^{113} were obtained in the wavelengths λ = 3261, 4678, 4800, and 5085 Å with the use of a 10-in. wellblazed plane diffraction grating mounted in the two-mirror (multiple-wavelength) monochromator of 40-ft focal length. The findings were: $Cd^{109}-Cd^{113}$ isotope shift in the 3261-Å resonance line, 0.033 ± 0.005 cm^{-1}, with the sign of the volume-dependent isotope shift, and hfs separation in the 5s6s $^3S_1$ state, $\Delta\nu(Cd^{113}) = -0.407 \pm 0.005$ cm^{-1}. (The single previously quoted value was obtained with natural Cd.) The three 5s6s to 5s5p ^3P lines display isotope shifts that are smaller than the precision of the experiment. A factors of Cd^{107}, Cd^{109}, and Cd^{111} are obtained from the spectroscopic data and the published resonance and level-crossing data. The isotope shift is studied in combination with other results in the light of possible nuclear polarizability effects. (auth)

38118 THE GAMMA-RAYS FOLLOWING THE DECAY OF ^{176}Ta. Akira Hashizume and Yoshihiko Tendow (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Japan, 18: 1107-11(Aug. 1963).

The gamma rays following the decay of 8-hour Ta^{176} were investigated using scintillation techniques. Ta^{176} was produced by two different procedures: first by the reaction $Ta^{181}(p,6n)W^{176}$ and the electron-capture decay $W^{176} \rightarrow Ta^{176}$; second by the reaction $Lu^{175}(\alpha,3n)Ta^{176}$. The gamma spectra, containing gamma rays of up to ~3 Mev, revealed a very complex structure. The spectrum was decomposed into at least 23 gamma rays using response functions of NaI(Tl) for mono-energetic gamma rays. Sum coincidence and ordinary coincidence measurements were performed. (auth)

38119 DECAY OF ZINC 72. Masayasu Ishihara (Tokyo Univ.). J. Phys. Soc. Japan, 18: 1111-15(Aug. 1963).

Decay characteristics of Zn^{72} were studied. Zn^{72} was produced by the (γ,α) reaction on germanium and separated chemically. Radiations were measured with a scintillation spectrometer. The half life of this nuclide was determined to be 36.5 hours. The decay goes mainly with a 0.3-Mev beta component to a level which decays with a 145-kev gamma ray followed by a 18-kev gamma transition. Another weak component is followed by a 190-kev and the same 18-kev gamma transitions. The decay scheme is discussed. (auth)

38120 ACTIVATION BY REACTOR NEUTRON FLUX. W. Schneider. Kerntechnik, 5: 334-8(Aug. 1963). (In German)

The equation describing the production of radioactive materials was derived in a simplified manner accompanied by a detailed illustration of the time function of radioactivity during and after irradiation by reactor neutrons. Important applications are mentioned with different examples of how to use the activation equation in the most effective way. (auth)

38121 HYPERFINE INTERACTIONS IN THE GROUND STATE AND 21.7-kev STATE OF Eu^{151} IN EUROPIUM IRON GARNET. I. Nowik and S. Ofer (Hebrew Univ., Jerusalem). Phys. Rev., 132: 241-5(Oct. 1, 1963).

The hyperfine interactions of the ground state and 21.7-kev state of Eu^{151} in europium iron garnet were measured at 300, 81, and 20°K using the technique of Mössbauer absorption. Values of (335 ± 50), (570 ± 35), and (670 ± 100) kOe were found for effective magnetic fields acting on the Eu nuclei in europium iron garnet at the temperatures of 300, 81, and 20°K, respectively. These values are in agreement with theoretical calculations of the nondiagonal matrix elements associated with the admixture of states produced by the exchange interaction. The value of the quadrupole interaction eQ_0q_{eff} of the ground state of Eu^{151} in europium iron garnet was found to be (−240 ± 100) Mc at 81°K. The results yield an assignment of a spin of $^7/_2$ for the 21.7-kev level and a value of μ = (2.54 ± 0.15) n.m. for the magnetic moment of this level. (auth)

38122 HYPERFINE STRUCTURE OF Hg^{197} AND Hg^{199}. Carl V. Stager (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 132: 275-9(Oct. 1, 1963).

The hyperfine structure of the $^3P_1$ state of Hg^{197} and Hg^{199} was measured by a microwave-optical experiment. This involves optical excitation to the desired state, paramagnetic resonance in this state, and an optical method of detecting the paramagnetic resonance. The paramagnetic resonances were obtained between different F levels as a function of magnetic field. Quadratic Zeeman corrections were estimated by second-order perturbation theory and the corrected transition frequencies were then extrapolated to zero field. The zero-field hyperfine-structure splittings in the $^3P_1$ state are Hg^{197}(F = $^3/_2$ to F = $^1/_2$) = 23,086.37(2) Mc, Hg^{199}(F = $^3/_2$ to F = $^1/_2$) = 22,128.56(2) Mc. Hyperfine-structure constants A are obtained which are correct to second order. These are combined with the known nuclear magnetic moments to give the hyperfine-structure anomaly in the $^3P_1$ state: $\Delta(^3P_1, Hg^{199}, Hg^{201})$ = −0.00147(1), and the anomaly of the hyperfine-structure interaction for the 6s electron in the $^3P_1$ state: $\Delta(s_{1/2}, Hg^{199}, Hg^{201}) = -0.00175(9)$. (auth)

38123 NUCLEAR MOMENTS OF Sc^{44} AND Sc^{44m}. D. L. Harris and J. D. McCullen (Princeton Univ., N. J.). Phys. Rev., 132: 310-15(Oct. 1, 1963). (PUC-1963-102)

The nuclear moments of Sc^{44} and Sc^{44m} were measured using the atomic beam magnetic resonance method. The results are: I = 2, $|\mu|$ = 2.56 ± 0.03 nm, |Q| = 0.14 ± 0.08 b, with $\mu/Q > 0$; I = 6, $|\mu|$ = 3.96 ± 0.15 nm, |Q| = 0.37 ± 0.29 b, with $\mu/Q < 0$. Observations of multiple quantum transitions in the I = 2 state give a value for g_J in the $^2D_{\frac{3}{2}}$ electronic state of 1.2008 ± 0.0003 if μ(I = 2) > 0, g_J = 1.1997 ± 0.0003 if μ(I = 2) < 0. These results are discussed with emphasis on the pertinence of the odd-group model for odd-odd nuclei in this region of the periodic table. (auth)

38124 RADIOACTIVE DECAY OF Nb^{95}. L. M. Langer and D. E. Wortman (Indiana Univ., Bloomington). Phys. Rev., 132: 324-8(Oct. 1, 1963).

The decay of Nb^{95} was investigated in order to check on the unusually short comparative half life, which had been reported for the twice-forbidden ground state to ground state beta transition. It was found that the 0.924-Mev beta group has an abundance of only 0.075% rather than the 1 or 2% reported previously. As a consequence, log ft ≥ 10.8 rather than 9.7. The main decay is by a 159.7 ± 0.5-kev beta transition followed by a 764.5 ± 0.5-kev gamma ray. The gamma transition appears to be E2 with a K/(L + M) internal conversion ratio of 7.5 ± 0.1 and $\alpha_K = (1.1 \pm 0.1) \times 10^{-3}$. No evidence was found for an additional 752 kev gamma transition. (auth)

38125 BETA DECAY OF Li^9. David E. Alburger (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 328-34(Oct. 1, 1963). (BNL-6656)

A beryllium rabbit irradiated with neutrons from the t + d reaction was transferred repeatedly to remote scintillation detectors by means of a timed pneumatic system. The spectrum of beta rays emitted by the Be sample and detected by means of a Pilot-B scintillator displays a strong component with a half life of ~1 sec and β_{max} ~3.5 Mev and a weaker component with a half life of 0.19 ± 0.03 sec and β_{max} = 13.5 ± 0.3 Mev. These activities are identified as He^6 from the $Be^9(n,\alpha)He^6$ reaction and as Li^9 from the $Be^9(n,p)Li^9$ reaction; respectively. A much weaker component is assigned to N^{16} resulting from oxygen in the sample. Beta rays in coincidence with neutrons detected in a second Pilot-B crystal have an end-point energy of 11.0 ± 0.4 Mev. The coincidence spectrum from the neutron-detecting crystal displays a principal component corresponding to a neutron energy of 0.7 ± 0.2 Mev and gives some evidence for neutrons having an energy of 3 to 4.5 Mev. From these data, together with a shape analysis of the beta-ray singles spectrum, it is deduced that Li^9 decays with a 25% branch to the ground state of Be^9(log ft = 5.5 ± 0.2) and with a 75% branch mostly to the known 2.430 Mev level (log ft = 4.7 ± 0.2). Both log ft values require allowed transitions and are compatible with a probable shell-model spin-parity assignment of $^3/_2$− to Li^9 and with the tentative assignment of $^5/_2$− given previously to the 2.430 Mev level. The cross section for forming Li^9 with neutrons of about 15.5 Mev is ~0.7 mb. (auth)

38126 BETA DECAY OF Li^8. D. E. Alburger (Brookhaven National Lab., Upton, N. Y.), P. F. Donovan, and D. H. Wilkinson. Phys. Rev., 132: 334-42(Oct. 1, 1963). (BNL-7067)

The beta decay of Li^8, formed in the $Li^7(d,p)Li^8$ reaction, was studied by measuring the energy distribution of the alpha particles that come from the subsequent breakup of Be^8. The effects of the penetration into backing foils of the Li^8 recoils were corrected for by comparing, for several deuteron bombarding energies, the alpha-particle spectra seen using a very thin foil target and the same target backed by a thick foil. The resulting correct alpha-particle spectrum is adjusted for various small effects including that due to electron-neutrino recoil and then compared with a prediction based on the empirical alpha-alpha scattering phase shifts, themselves adjusted by the subtraction of a hard-sphere phase shift. It is shown that the prediction is rather insensitive to the choice of hard-sphere radius. The agreement between the beta-decay data and the alpha-alpha phase shifts in the peak position, the 2.9-Mev state of Be^8, is excellent as it is also in the shape of the transition probability distribution on the low- (alpha-particle) energy side of the peak where the falloff of intensity is experimentally followed over two orders of magnitude. On the high-energy side of the peak, the familiar discrepancy is found in the sense that the transition probability is much too high to be explained by the first excited state alone. The present results, in addition to constituting an accurate comparison between Li^8 beta decay and alpha-alpha scattering, strengthen the interpretation of the reaction $Be^9(p,d)Be^8$ in terms of the ghost of the ground state of Be^8 and provide necessary data for discussing Li^8 and Be^8 decay to regions of higher excitation in Be^8 where the effects of transitions to the tail of the first T = 1 state of Be^8 are probably important. (auth)

38127 TRANSVERSE POLARIZATION OF THE K-CONVERSION ELECTRONS FOLLOWING THE BETA

DECAY OF Hg^{203}. R. A. Llewellyn and R. M. Steffen (Purdue Univ., Lafayette, Ind.). Phys. Rev., 132: 346-54 (Oct. 1, 1963). (TID-19115)

The transverse polarization of the K-conversion electrons following the β decay of Hg^{203} was investigated. A lens spectrometer was used to focus the conversion electrons on a Mott-scattering foil and the right-left asymmetry of the scattered conversion electrons in coincidence with the preceding β particles was measured. A detailed discussion of the instrumental corrections is presented. The degree of transverse polarization of the Hg^{203} conversion electrons in the plane defined by the momenta p_β = mv of the β particles and p_e of the conversion electrons is described by $P_{II}(\theta) = K(v/c) \sin\theta$, where θ is the angle between p_β and p_e. The experiments yielded the value of the polarization constant K = +0.62 ± 0.08. The positive sign of K implies that the spin of the conversion electrons is pointing in the same direction as the β-particle momentum p_β. A comparison with the theory of Becker and Rose shows that the experimental value of K is compatible with the spin assignments $I_i = 1/2$ and $I_i = 3/2$ to the ground state of Hg^{203}. The spin $I_i = 5/2$ is excluded. The most probable spin assignment is $I_i = 3/2$, which gives good agreement with the observed polarization if the ratio y' of the scalar and the vector-type beta matrix elements is y' = −1.25 ± 0.15. (auth)

38128 DECAY OF Tm^{173}. C. J. Orth, M. E. Bunker, and J. W. Starner (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 132: 355-61(Oct. 1, 1963). (LADC-5801)

The mass assignment of Tm^{173} was confirmed by cross bombardments involving the reactions $Er^{170}(\alpha,p)Tm^{173}$, $Yb^{173}(n,p)Tm^{173}$, and $Yb^{174}(\gamma,p)Tm^{173}$ with isotopically enriched targets, and its decay was studied by β-ray and γ-ray scintillation spectrometry. The half life of Tm^{173} is 8.24 ± 0.08 h. Three gamma rays, with energies (and relative intensities) of 66 (0.01), 399 (1.0), and 465 (0.09) kev, were observed. Analysis of the β-ray spectrum indicates the presence of two major groups with end-point energies of 1.32 ± 0.03 Mev (2%) and 0.89 ± 0.04 Mev (98%). Gamma-gamma coincidence measurements and the γ-ray intensity data show that the 0.89-Mev β-ray group is composed of two components which differ in energy by 66 kev. The proposed decay scheme for Tm^{173} involves excited levels in Yb^{173} at 399 and 465 kev. The 399-kev level is an isomeric state with a 3.5 ± 0.3 μsec half life, and it de-excites by a pure E2 transition which is hindered by a factor of ≈1.6 × 10^3 compared to the single-particle estimate. This hindrance is attributed to violation of the asymptotic selection rules for deformed nuclei. (auth)

38129 EXCHANGE AND OVERLAP EFFECTS IN ELECTRON CAPTURE AND IN RELATED PHENOMENA. John N. Bahcall (California Inst. of Tech., Pasadena). Phys. Rev., 132: 362-7(Oct. 1, 1963).

Theoretical expressions are presented for L/K electron capture ratios and electron capture-positron emission ratios that include the effects of electron exchange and imperfect atomic overlap. The role of electron exchange and imperfect atomic overlap in the determination of fluorescence yields is also discussed. In order to facilitate experimental comparisons, numerical values are presented for the exchange and overlap corrections to L/K ratios and electrons capture-positron emission ratios; these corrections were calculated with the analytic Hartree-Fock wave functions of Watson and Freeman. The corrected L/K ratios are in good agreement with the precisely measured L/K ratios, showing that overlap and exchange corrections explain the systematic disagreement between the predictions of the usual electron capture theory and experiment. (auth)

38130 LIFETIME MEASUREMENTS ON THE FIRST EXCITED STATES OF O^{17} AND F^{18}. J. Lowe and C. L. McClelland (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 367-71(Oct. 1, 1963). (BNL-6963)

The mean life of the first excited state of O^{17} at 871 kev was measured by a pulsed Van de Graaff beam technique. A value of τ_m = (0.263 ± 0.008) nsec was found. Similar measurements on the first excited state of F^{18} at 940 kev established an upper limit to the mean life: $\tau_m < 0.2$ nsec. (auth)

38131 FINE STRUCTURE EFFECTS IN THE FISSION OF U^{235}. Edward L. Cooperman and R. R. Roy (Pennsylvania State Univ., University Park). Phys. Rev., 132: 371-3(Oct. 1, 1963).

By the use of a Frisch-gridded double ionization chamber the energy and mass distribution of U^{235} fission fragments under thermal neutron fission were studied in coincidence with relatively high-energy prompt-fission γ rays. The data were electronically analyzed and the results printed on paper tape, transferred to IBM cards, and analyzed by an IBM 7074 computer. Runs were taken for fission fragments in coincidence with prompt-fission γ's > 2 Mev and γ's > 3 Mev and the results were compared with fission fragments corresponding to all γ rays. Pronounced structural effects were noted in the kinetic-energy distribution and in the mass ratio, the magic-number nucleus N = 82, Z = 50 preferentially emitting higher energy γ rays. The symmetric fission yield was found to increase the γ-ray energy, thus offering the possibility that the extra excitation energy of symmetric fission fragments may be carried off in the form of higher energy γ rays. (auth)

38132 STUDY OF THE Ni(n,p)Co REACTION. L. D. Singletary (Lockheed Missiles and Space Co., Palo Alto, Calif.), E. N. Strait, and S. H. Ahn. Phys. Rev., 132: 378-83(Oct. 1, 1963).

The total cross section and energy spectrum for the (n,p) reaction on nickel was measured for 15-Mev neutrons using a modified broadrange magnetic spectrograph and nuclear emulsions. Proton spectra were measured at scattering angles of 0° and 138°. A nuclear temperature of 1 Mev was determined from the 138° spectrum. If isotropy of the compound nucleus reaction products is assumed, the cross section for the compound nucleus part of the (n,p) reaction can be estimated as 650 ± 150 mb. The additional contribution from direct interaction is estimated as 160 ± 80 mb. (auth)

38133 (p,pxn) REACTIONS OF Br^{79} AND Br^{81} WITH 2.9-Gev PROTONS. Norbert T. Porile and Shigeo Tanaka (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 397-400(Oct. 1, 1963). (BNL-6992)

Cross sections for the (p,pxn) reactions of Br^{79} and Br^{81} were measured at 2.9 Bev. The cross sections decrease monotonically as x increases, and the decrease with increasing x is faster for Br^{79} than for Br^{81}. The results are compared with Monte Carlo cascade-evaporation calculations. The experimental values are larger than the calculated ones for x ≤ 3 but are in good agreement for x = 4 to 5. The systematics of (p,pxn) reactions at high energies are considered for a number of targets. A quantitative analysis of the (p,p3n) and (p,p4n) reactions indicates that the evaporation process determines the variation in cross section from target to target. (auth)

38134 SCATTERING OF 300-Mev POSITRONS FROM COBALT AND BISMUTH. J. Goldemberg, J. Pine, and D. Yount (Stanford Univ., Calif.). Phys. Rev., 132: 406-13 (Oct. 1, 1963).

Positrons and electrons from the Stanford Mark III linear accelerator were scattered from cobalt and bismuth at 300 Mev. The ratio R, equal to $(\sigma_- - \sigma_+)/(\sigma_- + \sigma_+)$, was measured at a number of angles from 10° to 45° for cobalt and from 5° to 45° for bismuth. Two experiments are reported: a high-precision experiment with poor energy resolution, suitable for measuring the small values of R found at small angles, where inelastic scattering is not important; and an experiment with somewhat lower precision but better energy resolution, suitable for measuring the larger values of R found at angles where inelastic scattering must be taken into account. The elastic scattering data are in good agreement with phase-shift calculations of Herman, Clark, and Ravenhall, who used nuclear charge distributions which fit earlier electron scattering data. The inelastic data, for which no reliable predictions exist, indicate that $R_{inelastic}$ is generally smaller than $R_{elastic}$. This suggests that the inelastic scattering is better described by the first Born approximation, in which R = 0, than is the elastic scattering. (auth)

38135 SCATTERING OF ELECTRONS AND POSITRONS BY COBALT AND BISMUTH: CALCULATIONS. Robert Herman (General Motors Research Labs., Warren, Mich.), B. C. Clark, and D. G. Ravenhall. Phys. Rev., 132: 414-21(Oct. 1, 1963).

Partial-wave calculations of electron and positron scattering by cobalt and bismuth are presented, and compared with the experimental results of Goldemberg, Pine, and Yount. A physical description of the scattering process is given which throws light on the general behavior of the calculational cross sections. Their dependence on incident energy, and on the assumed nuclear charge distribution is discussed. (auth)

38136 NEGATIVE PION PHOTOPRODUCTION FROM BISMUTH ACCOMPANIED BY NEUTRON EMISSION. Avivi I. Yavin and Giovanni de Pasquali (Univ. of Illinois, Urbana). Phys. Rev., 132: 431-3(Oct. 1, 1963).

The reaction $\gamma + Bi^{209} \rightarrow \pi^- + Po^{209-x} + xn$ was investigated using 250-Mev bremsstrahlung. Alpha counting technique was selected since it permits unambiguous identification of the produced radioactivity as coming from polonium. The effective cross section σ_x for the production of Po^{209-x} peaks at x = 2. This result is in fair agreement with calculations based on an impulse approximation model which assumes (1) the π^- is photoproduced from a free neutron close to the surface, (2) the π^- is emitted without undergoing any collision, (3) the neutron emission results from the interaction of the recoiling proton with the Bi^{208} spectator nucleus, (4) this process can be treated as a (p,xn) reaction initiated by a free proton. The sum of the cross sections σ_x is ~2.5 mb. This value is approximately 20 times that for π^- photoproduction from a free neutron, and is therefore compatible with a surface interaction model. (auth)

38137 α-DECAY OF Cm^{245} AND Cm^{246}. L. M. Belov, B. S. Dzhelepov, R. B. Ivanov, A. S. Krivokhatskii, V. G. Nedovesov, and V. P. Chechev. Radiokhimiya, 5: 394-5 (1963). (In Russian)

Tabulated data are given on Cm^{245} and Cm^{246} α spectra measured with a magnetic α spectrometer. The obtained data on energies and intensities of Cm^{245} and Cm^{246} α groups are correlated with published data. Levels and characteristics of Cm^{245} daughter nucleus are also included. (R.V.J.)

38138 NUCLEAR REACTIONS WITH ORIENTED TARGET NUCLEI AND POLARIZED BEAMS. J. M. Daniels (Instituto de Fisica, San Carlos de Bariloche, Rio Negro, Argentina) and J. Goldemberg. Rept. Progr. Phys., 25: 1-36(1962).

The principal methods of orienting nuclei are reviewed, and a list is given of the nuclei for which a method of orientation has been established. The factors that affect the degree of orientation which can be attained in practice are discussed, and numerical values of typical cases are given. The methods that are available for producing beams of polarized protons, neutrons and γ rays are reviewed, and values are given for the fluxes which can be achieved. The problem of the production and dissipation of heat in the target of oriented nuclei is treated at some length with numerical examples for a typical target and typical beams of thermal neutrons, resonance neutrons, 3 Mev neutrons and 17.6 Mev γ rays. Values are obtained for the magnitude of the heating effect in each case, and for the number of nuclear reactions which occur in the target for unit heat production. Experiments using oriented target nuclei and polarized or unpolarized beams are suggested and discussed. Tables are given of various reaction cross sections that may be needed for designing experiments of the type discussed. 96 references. (auth)

38139 THE MÖSSBAUER EFFECT. A. J. F. Boyle and H. E. Hall (Univ. of Manchester, Eng.). Rept. Progr. Phys., 25: 441-524(1962).

The recoilless emission and resonant absorption of low energy γ-rays by solids (Mössbauer effect) are reviewed, with particular reference to the present and future applications to solid state and nuclear physics. 120 references. (auth)

38140 SECOND MOMENT OF THE NUCLEAR RESONANCE LINE FOR SPIN 5/2 NUCLEI. I. Biryukov and I. Berson (Organic Synthesis Inst., Riga). Soviet Phys.-Solid State (English Transl.), 5: 364-5(Aug. 1963).

An estimate was made of the second moment of the nuclear quadrupole resonance line for spin $^5/_2$ nuclei with an internal electric field of axial symmetry under the assumption that the field gradients have a common direction. (auth)

38141 TEMPERATURE DEPENDENCE OF NUCLEAR QUADRUPOLE RESONANCE FREQUENCIES OF Sb^{121} IN CERTAIN SINGLE CRYSTALS. V. S. Greschishkin and I. A. Kyuntsel' (Perm State Univ., USSR). Soviet Phys.-Solid State (English Transl.), 5: 694-5(Sept. 1963).

The nuclear quadrupole resonance of Sb^{121} was investigated in $SbCl_3$, $2SbCl_3C_6H_6$, $SbCl_3C_6H_5C_2H_5$, and $2SbCl_3C_6H_5C_6H_5$ in the temperature range from 77 to 340°K. The temperature coefficient was highest in $SbCl_3C_6H_5C_2H_5$ at 17 kc/deg. Also in $SbCl_3C_6H_5C_2H_5$ a very strong NQR line was observed with the signal-to-noise ratio of the order of 20. A structural transition was observed in $2SbCl_3(C_6H_5)_2$. The crystal changes its color from green at low temperatures to blue-green at room temperature. The molecular compounds $SbCl_3$ exhibited interesting plastic properties (the presence of structural transitions). (P.C.H.)

38142 ON THE PHOTOEFFECT ON NUCLEI OF MASS 3. U. Eichmann (Universität, Freiburg i. B.). Z. Physik, 175: 115-38(1963). (In German)

The photo-disintegration of three-particle nuclei into a deuteron and an outgoing nucleon was treated for photon energies up to 35 Mev. The formalism was developed in terms of multipole expansions of the vector potential in-

cluding quadrupole transitions. The initial ground state of the three-particle nucleus was approximated by variational wavefunctions taking account of the asymmetry term. For the final state, plane waves were used and the effect of the interaction between deuteron and outgoing nucleon was taken into account. Numerical values of the total and the differential photo-disintegration cross section for the deuteron + nucleon channel were computed under different assumptions on the wavefunctions, to allow comparison with experiment when available. (auth)

38143 RESONANCE SCATTERING OF A 7.28-Mev GAMMA LINE ON Pb^{208}. Hans H. Fleischmann and Friedrich W. Stanek (Technische Hochschule, Munich). Z. Physik, 175: 172-6(1963). (In German)

From the known scattering of the 7.28 Mev line of the neutron capture spectra of Fe^{56}, under the assumption of a single level of Pb^{208} contributed by scattering, the ground transition width was determined to be $\gamma_0 = 0.80 \pm 0.08$ ev. For the branching ratio γ/γ_0 of this state a value of 1.4 was obtained with an uncertainty of a factor of 1.5. (tr-auth)

38144 SINGLE PARTICLE ENERGIES OF NUCLEAR MATTER AND THE REFERENCE SPECTRUM METHOD. P. Mittelstaedt (Massachusetts Inst. of Tech., Cambridge). Z. Physik, 175: 184-99(1963). (TID-18573). (In German)

The single-particle energies and the ground-state energy of a superfluid system of nuclear matter were investigated. There were two difficulties in calculating these quantities in the t-matrix approximation: on account of the structure of the $\underline{t}$-matrix equation, the single particle energy is a very complicated expression, which cannot be evaluated explicitly in general; and due to the superfluidity of nuclear matter, there are singularities in the $\underline{t}$-matrix. To overcome these difficulties, the reference spectrum method, recently proposed by Bethe et al., was proposed. The most important properties of a superfluid medium, the shift of the ground state energy and the gap in the single-particle spectrum, can then be described qualitatively. The quantitative results, however, are not satisfying. Furthermore, the estimation of the single-particle potential is very much simplified. However, this is useful only for hole states. For particle states $\underline{k} > \underline{k}_F$, the single-particle energy cannot be calculated with sufficient accuracy on account of complications coming from the rearrangement energy. (auth)

38145 ISOMERIC SHIFT AND QUADRUPOLE SPLITTING OF MÖSSBAUER EFFECT OF Fe^{57} IN IRON COMPOUNDS. Werner Kerler, Wolfgang Neuwirth, and Ekkehard Fluck (Universität, Heidelberg). Z. Physik, 175: 200-20(1963). (In German)

Data from previous measurements are discussed from the point of view of isomeric shift and quadrupole splitting. For a comparison of isomeric shifts the magnitude of temperature shifts has to be regarded. Information about electric field gradients arises from the magnitude and the temperature dependence of quadrupole splittings. After putting the data into a suitable form, characteristic regions of the value of line shift, quadrupole splitting, and temperature dependence of the splitting for different bond types were obtained. Besides this, influences of the crystal field were considered. Different types of contributions to the electric field gradient are discussed. The main features of field gradients in iron ions and molecules with and without closed electron shells were derived and compared with the experimental results. The result that the isomeric shifts for covalent bond iron in the oxidation states 0, +2, +3 and metallic bond iron are distributed over the same region while the ions Fe^{2+}, Fe^{3+}, and $[Fe^{VI}O_4]^{2-}$ each have characteristic values is discussed. π-bonds in addition to σ-bonds and partially ionic bonds have to be considered. The sign of field gradients was regarded for iron ions and molecules, where ligands were exchanged. Examples for the interdependence of the structure of multicenter molecules and ions and the data are given. (auth)

38146 BRANCHING RATIOS OF Ag^{110}($T_{1/2}$ = 24.4 SEC). L. Frevert, P. H. Heckmann, and A. Flammersfeld (Universität, Gottingen, Ger.). Z. Physik, 175: 221-6(1963). (In German)

The branching ratios of 24-sec Ag^{110} were measured with scintillation spectrometers. An upper limit of 0.9% is given for decay by K-electron capture. (auth)

38147 THE SCATTERING OF FAST NEUTRONS FROM W^{184}. A. B. Smith (Argonne National Lab., Ill.). Z. Physik, 175: 242-56(1963). (In English)

Neutrons with energies of 0.3 to 1.5 Mev were scattered from W^{184}. Pulsed-beam fast time-of-flight techniques including a magnetic bunching system were utilized to resolve the elastically scattered neutrons from those inelastically scattered. The differential elastic cross section was measured at 50-kev intervals with an $\approx$20-kev incident neutron energy spread. The differential cross sections for inelastic scattering resulting in the excitation of residual nuclear levels at 111 ± 5, 365 ± 10, 690 ± 40, 900 ± 25, 1000 ± 30, and 1120 ± 30 kev were determined. In all instances the inelastically scattered neutrons were emitted, within experimental error, isotropically. The experimental results were compared with those obtained in previous work and with the predictions of theory. (auth)

38148 ON THE ELASTIC SCATTERING OF HIGH-ENERGY ELECTRONS ON Bi^{209}. Florian Scheck (Universität, Freiburg i. B.). Z. Physik, 175: 264-70(1963). (In German)

The elastic scattering of electrons by Bi^{209} at 183 Mev was calculated on the assumption that the charge distribution of this nucleus can be represented by the sum of the charge distribution of Pb and the charge density of the 83th proton. This model, already used with good success for calculations of μ-mesic atoms, gave an improved description of the electron scattering of Bi and reduced the discrepancy for the absolute values of the differential cross section mentioned by Crannell et al. from 34 to 19%. (auth)

38149 MEASUREMENT OF THE NUCLEAR SPECIFIC HEAT OF IRIDIUM AND RHENIUM IN AN IRON ALLOY. A. V. Kogan, V. D. Kulkov, L. P. Nikitin, N. M. Reinov, and M. F. Stelmakh (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 1-7(Aug. 1963). (In Russian)

A method is described that can be applied for measuring very small nuclear specific heats and for estimating the nuclear relaxation times in alloys. The nuclear specific heat of Re–Fe and Ir–Fe alloys of various concentration is measured. The strengths of the effective magnetic fields acting on the impurity nuclei in the alloys are determined: $H_{eff} = (6.7 \pm 0.7) \times 10^5$ gauss for Re and $H_{eff} = (1.35 \pm 0.3) \times 10^6$ gauss for Ir. The magnetic moment of the Ir^{192} is found to be $(1.8^{+0.6}_{-0.5})\mu_{nucl}$. (auth)

38150 KINETIC ENERGY OF FRAGMENTS PRODUCED IN SYMMETRIC FISSION OF U^{235}. P. P. Dyachenko, B. D. Kuzminov, L. S. Kutsaeva, V. N. Okolovich,

G. N. Smirenkin, and A. N. Utyuzhnikov. Zh. Eksperim. i Teor. Fiz., 45: No. 2, 8-12(Aug. 1963). (In Russian)

The mean kinetic energy of fragments produced in symmetric fission of U^{235} induced by 7, 14.5, and 20 Mev neutrons is measured. It is shown that in the investigated neutron energy range the energy of fission fragments does not change within the experimental errors. The results of the measurements are discussed from the standpoint of the hypothesis of existence of two types of fission. (auth)

38151 INELASTIC SCATTERING OF 2.66-Bev π^- MESONS ON NUCLEONS AND CARBON NUCLEI. G. I. Merzon and L. P. Kotenko (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 18-25 (Aug. 1963). (In Russian)

The inelastic interaction characteristics of 2.66 Bev pions in a propane bubble chamber are studied. It is found that at this energy the inelastic π^-p interaction cross section is 24.3 ± 3.0 mb. The distribution of π^-p and π^-n interactions with respect to secondary charged particles multiplicity is in accordance with the isobar variant of the statistical theory. The multiplicity distribution of secondary relativistic particles is the same for interactions on hydrogen and carbon. It is found that the effective number of quasifree protons (neutrons) in the carbon nucleus is close to unity. An attempt is made to study pion resonances in $(\pi^-,p) \rightarrow (\pi^-,\pi^+,n)$ for neutron energies $T_n \leq 0.2$ Bev. (auth)

38152 CROSS SECTION OF THE $Rh^{103}(\gamma,p)$ REACTION. B. S. Ishkhanov, E. N. Kornienko, Yu. I. Sorokin, V. G. Shevchenko, and B. A. Yurev (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 38-42(Aug. 1963). (In Russian)

The yield curve of the reaction $Rh^{103}(\gamma,p)$ is measured for energies $E_{\gamma max}$ lying in the range from 14.5 to 32.5 Mev. The measurements were performed by recording the photoprotons with scintillation spectrometers. The cross section calculated by the Penfold and Leiss matrix method reaches the value 8 ± 1.5 mb at the maximum at 19 ± 0.5 Mev. The half-width at the peak is ~5.5 Mev. After a drop in the vicinity of 21-23 Mev an increase of the cross section is observed that apparently is related to electric quadrupole absorption in the region of 25-30 Mev. Up to ~32 Mev the integral cross section for the (γ,p) reaction is 85 ± 15 Mev · mb. (auth)

38153 ANGULAR DEPENDENCES IN MULTI-CHARGED PARTICLE PRODUCTION BY 75-350 Mev PROTONS. M. M. Makarov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 56-63(Aug. 1963). (In Russian)

The angular distributions of secondary multi-charged particles and fast protons relative to the beam are measured for incident proton energies of 76, 100, 200, and 350 Mev. The experimental angular distributions of fast protons relative to the beam, the correlations between the fast protons and multi-charged particles, and the variation of the correlations depending on the emission angle and beam energy are compared with the usual calculation of the intranuclear cascade according to the Monte Carlo method and with the quasi-elastic ejection calculation. The comparison indicates that for proton energies of 70-100 Mev multi-charged particles are produced as a result of quasi-elastic scattering of the bombarding protons on instantaneous nuclear substructures. Data are obtained which show that the intranuclear momentum distribution of multi-charged particles in the nucleus is gaussian. (auth)

38154 $\bar{\Lambda}$-HYPERON PRODUCTION BY 7-8 Bev NEGATIVE π-MESONS ON HYDROGEN. V. A. Belyakov, V. I. Veksler, N. M. Viryasov, et al (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 88-9(Aug. 1963). (In Russian)

Observations on the production and decay of $\bar{\Lambda}$ hyperons are reported. The cross section for production of $\bar{\Lambda}$ by 7-8 Bev negative π mesons on hydrogen is estimated. It is found to be equal ~3 μb. (auth)

38155 POLARIZATION OF Λ-HYPERONS PRODUCED IN π^-C INTERACTIONS AT 7 Bev. V. A. Belyakov, Yung-chang Wang, V. I. Veksler, et al (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 90-2(Aug. 1963). (In Russian)

A search is made for Λ hyperons produced in collisions between 7 Bev π^- mesons and carbon nuclei. The Λ hyperons are produced without longitudinal polarization. (auth)

38156 RADIATIVE CAPTURE OF RESONANCE NEUTRONS BY THE Pr^{141} NUCLEUS. Jan Urbanec (Yan Urbanets) (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 93-7(Aug. 1963). (In Russian)

A single crystal scintillation spectrometer was used for measuring the spectra of hard γ quanta with energies between 3 and 7.5 Mev emitted as a result of resonance neutron capture by Pr^{141}. The relative intensities of the main transition for the first six resonances are determined on the basis of these measurements. Conclusions regarding the nature of the 85.1 ev resonance are deduced from the shape of the γ spectra. (auth)

38157 POLARIZATION OF ELASTICALLY SCATTERED 6.5-Mev DEUTERONS. Yu. A. Nemilov and L. A. Pobedonostsev. Zh. Eksperim. i Teor. Fiz., 45: No. 2, 103-6(Aug. 1963). (In Russian)

Asymmetry of double elastic scattering of deuterons on Be, B, C, Mg, Al, Fe, Se, Sb, Fe^{54}, Au, Co, and Mn is studied. The polarization and quadrupolarization of deuterons scattered by Fe nuclei are estimated. It is found that the polarization characteristics vary gradually with Z of the nucleus and do not depend on its spin. (auth)

38158 DETERMINATION OF THE MUTUAL ARRANGEMENT OF NUCLEON ASSOCIATIONS IN A NUCLEUS BY AID OF THE DIRECTED ORBITAL METHOD. S. Mattkhiz, V. G. Neudachin, and Yu. F. Smirnov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 107-15(Aug. 1963). (In Russian)

Some general rules based on the directed orbital method familiar from quantum chemistry are formulated that can be applied for determining the geometric arrangement of α clusters in a nucleus, the Nilsson orbit series or shell configuration being given. As an example, some excited states of O^{16} and C^{12} are considered and the geometric arrangement of α clusters in Ca^{40} is determined. In conclusion some critical remarks are made concerning the application of the α model to light nuclei. (auth)

38159 LEPTON DECAYS OF HYPERNUCLEI. V. A. Lyul'ka. Zh. Eksperim. i Teor. Fiz., 45: No. 2, 164-72 (Aug. 1963). (In Russian)

Lepton decays of hypernuclei are examined on the basis of the Lee-Yang four-fermion interaction. The photon and electron energy spectra and the electron angular correlations are obtained for $_\Lambda He^4 \rightarrow He^3 + \rho + e^- + \bar{\nu}$. The μ-meson decays, $_\Lambda He^4 \rightarrow He^4 + \mu^- + \bar{\nu}$ and $_\Lambda He^4 \rightarrow He^3 + \rho + \mu^- + \bar{\nu}$, are also considered. A method for determining the decay interaction constants is discussed for three-particle μ-meson decays. The probabilities for lepton decays of

hypernuclei are estimated under the assumption of a universal V–A-interaction. (auth)

38160 QUADRUPOLE RESONANCES OF ATOMIC NUCLEI. V. G. Shevchenko, N. P. Yudin, and B. A. Yurev (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 180-4(Aug. 1963). (In Russian)

Collective states of atomic nuclei excited by absorption of quadrupole γ quanta are considered in the shell model approximation. It is shown that in heavy nuclei the residual interaction leads to the appearance of two groups of states that are preferred with respect to energy and to the probability for quadrupole γ absorption. The group of states that shifts upwards relative to the position of the zero approximation levels forms the so-called quadrupole resonance of nuclear photodisintegration. The states that shift downward play an important role in the formation of effective nucleon quadrupole charge. The intensities of transitions to the indicated states exhaust almost all quadrupole transitions in nuclei. In light nuclei the existence of two preferred states is less pronounced. The mean energies of the indicated groups of quadrupole transitions are estimated for all the nuclei considered. (auth)

38161 SPATIAL CORRELATION OF NUCLEONS IN LIGHT NUCLEI. N. A. Vlasov. Zh. Eksperim. i. Teor. Fiz., 45: No. 2, 228-30(Aug. 1963). (In Russian)

The Coulomb energy differences of isobaric triplets of light nuclei are considered. The values indicate a relatively large mutual Coulomb energy of the pair of external protons and hence an appreciable spatial correlation between them. (auth)

38162 EMPIRICAL BEHAVIOR OF THE (n,p) CROSS SECTION FOR 14-15 Mev NEUTRONS. V. N. Levkovskii (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 305-11(Aug. 1963). (In Russian)

The absolute values of the (n,p) and (n,α) cross sections for 14-Mev neutrons were measured by the activation method. An analysis of data in the literature indicates that in the $12 < A < 150$ region $\sigma_{n,p}$ depends on Z and A of the target in a simple way. Comparison of the empirical formula obtained with the semi-empirical relation proposed by Gardner leads to a simple dependence of $\sigma_{n,p}$ on $Q_{n,p}$. (auth)

38163 CONTRIBUTION TO THE STATISTICAL THEORY OF NUCLEAR LEVEL SPACING. A. V. Malyshev. Zh. Eksperim. i Teor. Fiz., 45: No. 2, 316-24(Aug. 1963). (In Russian)

The parameter, a, which determines the density of nuclear levels in the Fermi gas model and also the dependence of nuclear temperature on mass number, are derived from experimental data on the mean distances between neutron s-resonances. The effective nuclear excitation energies for an even number of protons and neutrons correspond to the pairing energy calculations performed by P. E. Nemirovsky and Yu. V. Adamchuk on the basis of experimental nuclear mass values. The parameter, σ, which determines the level distribution with respect to total angular momentum, has been obtained by employing the mean square magnetic quantum numbers of nucleons in accordance with the shell model. The calculated values of parameters a and σ and of the nuclear temperatures for an excitation energy of 7 Mev are found to agree with other available data. It is also shown that at the indicated excitation energies the moments of inertia of nuclei far away from closed shells are approximately the same as those for rigid bodies. (auth)

38164 THE ^{23}Na(d,p)^{24}Na REACTION AND THE NUCLEAR STRUCTURE OF Na^{24}. C. Daum. Thesis, Amsterdam, Univ. of Amsterdam, 1962. 101p.

In this thesis the experimental results on the $Na^{23}(d,p)Na^{24}$ reaction at a deuteron energy of 7.8 Mev were shown and the nuclear structure of Na^{24} was discussed. The Butler-Born Approximation analysis and the Distorted-Wave Born Approximation analysis for the description of the angular distributions of the protons emerging from the reaction were dealt with in the first chapter. Chapter two presents the experimental results of angular distributions of protons from transitions to levels of Na^{24} in a region of excitation of 0 to 7 Mev. In the third chapter the interpretation of the nuclear structure of Na^{24} on the basis of the experimental results leads to the conclusion, that the unified model with pairing force and two-body interactions from the central force, the spin-orbit force, and the Sensor force between the odd proton and the odd neutron may describe the nuclear structure of Na^{24}. (auth)

38165 THE ONCE-FORBIDDEN BETA SPECTRUM OF Tl^{206}. David Allen Howe. Thesis, Bloomington, Ind., Indiana Univ., 1962. 90p.

The beta spectrum of Tl^{206} was measured in a 4π scintillation spectrometer. The Tl^{206} beta decay is a $0^- \rightarrow 0^+$ transition. The spectrum was found to have a nonstatistical shape. The shape of the spectrum was analyzed successfully in terms of the pseudovector interaction and no necessity for the inclusion of pseudoscalar contribution was found. Because of the short half life of Tl^{206} (4.2 min.), the beta spectrum of Tl^{206} was measured using Tl^{206} in secular equilibrium with Bi^{210m}. Bi^{210m}, an excited state located at 268 kev, α decays to Tl^{206} with a half-life of 2.6×10^6 years. The source material has to be spread over a large area in order to make a thin source. A large area scintillation spectrometer was constructed. On the basis of the V-A interaction in beta decay, a shape factor was calculated for $0^- \rightarrow 0^+$ transitions. Only the pseudovector coupling can contribute. (Dissertation Abstr.)

38166 PROPERTIES OF EXCITED STATES OF P^{31}. Gale Ion Harris. Thesis, Lawrence, Kan., Univ. of Kansas, 1962. 125p.

The capture reaction $Si^{30}(p,\gamma)P^{31}$ was utilized to study the properties of excited states of P^{31}. Approximately 40 resonances were observed in the yield of gamma rays from the bombardment of natural silicon (92.17% Si^{28}, 4.71% Si^{29}, and 3.12% Si^{30}) with protons of energies from 975 to 1830 kev. With the exception of the 50-kev wide resonance at 1651 kev which is known to be due to Si^{28}, the resonances were all narrow (≤3 kev) and most were identified elsewhere as due to Si^{29} or Si^{30}. Those at E_p = 1177, 1204, 1324, 1392, 1400, 1481, 1489, and 1509 kev were identified as arising from the $Si^{30}(p,\gamma)P^{31}$ reaction by means of their gamma spectra. These identifications were verified by further work with enriched Si^{30} targets. The remaining resonances were not studied in detail. Decay schemes for these resonances are proposed from a study of their gamma spectra and from coincidence measurements. Gamma rays were detected with NaI(Tl) detectors. The decay of intermediate states through which the resonance levels decay were found to be in general agreement with the results of Broude, Green, and Willmott. Some exceptions were found, however. The 4.26-Mev level was found to decay to the ground-state and first-excited state with the relative intensities 84% and 16%, respectively. There was also evidence that the 3.51-Mev level decays either to the 1.27 or the 2.23-Mev level (or both) in addition to the known decay to the ground-state. Similarly, the

5.01-Mev level was found to decay to the first-excited state in addition to the decay to the ground-state. Angular distribution and triple correlation measurements led to the assignments 1177(7/2), 1204(5/2), 1324(5/2), 1392(5/2), 1400(3/2), 1481(3/2), 1489(5/2), and 1509(5/2), all with positive parity, and the assignments 3/2+, (5/2+), or (7/2+) for the 3.41-Mev level and 3/2+ for the 4.26-Mev level. The assignment 1/2+ predicted by the rotational model for the 3.14-Mev level was definitely ruled out. M1-E2 mixing ratios were determined for many of the primary and secondary members of the cascades. The decay schemes and excitation curve were used in deriving the radiation widths for the resonance levels. A tabulation of the most commonly used theoretical angular distribution formulas for analysis of data from bombardment of spin-zero nuclei with spin-$\frac{1}{2}$ particles is given. (Dissertation Abstr.)

38167 OVERHAUSER EFFECT IN METALLIC SODIUM. Jonathan Freiberg Reichert. Thesis, St. Louis, Washington Univ., 1962. 132p.

The dynamic enhancement of the nuclear polarization, produced by the saturation of the conduction electron spin resonance, (the Overhauser effect) in metallic sodium was measured in order to study the electron-nuclear interaction in this substance. Previous measurements of the Overhauser effect in this substance indicated the presence, at room temperature, of a second nuclear spin-lattice relaxation mechanism, comparable to the electron nuclear hyperfine coupling. This seemed an anomalous result since the hyperfine coupling was considered to be the dominant mode of nuclear relaxation for metallic sodium. In order to eliminate many of the ambiguities in the early experiments, a double resonance spectrometer was constructed which was capable of making accurate measurements of all the dynamical variables expressed in the master equation governing the time evolution of the dynamic enhancement on a single sample. This system was able to measure the rate of rise of the nuclear polarization after the onset of saturation T_1^R, the rate of decay of the polarization after the saturation was removed T_1^D, the nuclear spin-lattice relaxation time T_1, and the absolute steady state nuclear polarization as a function of electron saturation. The experiment showed that only one time constant was involved in the time evolution of the nuclear polarization since $T_1 = T_1^D = 13.2 \pm 0.2$ milliseconds (at 29°C) within experimental error. The data on the enhancement as a function electron saturation give a value of the "leakage coefficient," f, to be 0.88 ± 0.05 (at 29°C). The value of T_1 and f enables T_1^e ($= 14.9 \pm 8$ milliseconds at 29°C), the spin-lattice relaxation time of the sodium nuclei due to their interaction with the conduction electrons, to be calculated. These data demonstrate that the electron-nucleon hyperfine coupling is the dominant mode of nuclear relaxation for sodium. These results are in agreement with theory. (Dissertation Abstr.)

38168 SCATTERING OF HIGH-ENERGY POSITRONS FROM HYDROGEN, COBALT, AND BISMUTH. David Eugene Yount. Thesis, Stanford, Calif., Stanford Univ., 1963. 248p.

A positron beam of 7×10^8 positrons per pulse (60 pulses per second) was obtained with the Stanford linear accelerator. This is approximately 1.4×10^{-4} times the intensity of the electron beam usually obtained under similar conditions. The energy is 300 Mev and the energy spread is 2%. Differences in elastic positron and electron scattering from hydrogen, cobalt, and bismuth were measured with systematic errors as small as ±1.0% of the cross sections, while the separate electron or positron points had relative systematic errors of as little as ±1.5% at different angles and energies. Statistical errors varied from ±0.5 to ±5% in measurements of positron cross sections covering a range from 1×10^{-32} to 2×10^{-32} cm^2 per steradian. Differences in the elastic scattering of positrons and electrons are expected to be of order Z/137, where Z is the atomic number of the target element (i.e., Z = 1, 27, and 83 for hydrogen, cobalt, and bismuth, respectively). In the case of hydrogen, positron scattering is expected to test the validity of the form factor analysis used in analyzing electron-proton experiments. In the cases of cobalt and bismuth, positron scattering provides a method for determining nuclear structure which is complementary to electron scattering. Positron-proton and electron-proton cross sections were identical within the experimental errors and were consistent with theory. The cobalt data showed a difference for electrons relative to positrons which is first positive but which becomes negative at higher momentum transfers. This is in general agreement with predictions for several models calculated in the second Born approximation. The measured difference for bismuth was oscillatory and was in poor agreement with the second Born predictions. (Dissertation Abstr.)

38169 A STUDY OF THE RESONANT CONTRIBUTION TO THE $C^{12}(d,n)N^{13}$ REACTION NEAR 4.00 Mev. John Wesley Verba. Thesis, Rochester, N. Y., Univ. of Rochester, 1962. 95p.

Measurements were made of the $C^{12}(d,n)N^{13}$ cross section as a function of angle and energy. The experimental results are analyzed and interpreted. The study was undertaken in an effort to get an improved understanding of interference effects between the stripping mode and the compound nucleus mode of this type of reaction. Nine angular distributions were obtained for the $C^{12}(d,n)N^{13}$ reaction in 50-kev steps over what appeared to be an isolated resonance at the bombarding energy of 4.00 Mev. In the analysis of the results the measured cross sections were divided into direct (slowly varying) components and resonant components on the basis of the energy dependence. A combination of the general reaction theory, as expressed by Blatt and Biedenharn, and the stripping theory of Butler was used to interpret the separated results and to show the validity of the decomposition. Small systematic discrepancies found in a one-level description tended to indicate the possible existence of a narrow second level. While the second or narrow level was only weakly resolved in this experiment, the wide first level was well resolved and some of the properties of the corresonding level of N^{14} could be deduced. The spin of this level was determined to be J = 1 and the parity either minus or plus depending on whether the direct amplitude has the same or opposite signs in the forward and backward directions. The flatness of the differential cross sections in the backward directions for certain energies led to the suggestion that the lowest two waves (l = 0, l = 1) of the incoming deuterons and outgoing neutrons may make the chief contribution to the yield in the direct interaction mode at large angles. This interpretation of the backward peaking was then shown to favor a negative parity for the wide level. (Dissertation Abstr.)

38170 MEASUREMENT OF SOME (d,n) REACTIONS USING A FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. Glenn Frederick Knoll. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 149p.

Measurements were made of the energies of neutrons from (d,n) reactions by means of their time-of-flight. The

measurements were made using The University of Michigan 42-inch cyclotron, and represent a continuation of a general effort to obtain higher precision in the determination of neutron energies. The objectives were to check the results obtained with an earlier version time-of-flight spectrometer for the $C^{12}(d,n)N^{13}$ and $O^{16}(d,n)F^{17}$ reactions, and to determine the Q-values of low-lying levels in Sc^{41} by means of the $Ca^{40}(d,n)Sc^{41}$ reaction. In the course of the investigation, a method was developed which permitted the Q-values of the neutron groups to be determined with an accuracy approaching that obtained with charged particles. The need to measure long flight times was eliminated by using beam pulse repetition periods of the same order as the neutron flight time. A prompt gamma ray from one pulse is detected at nearly the same time as a neutron from a preceding pulse, thus only short time intervals need be measured. For a particular flight path the interval can be reduced to zero, in which case the flight time is known to the same precision as the period of the beam pulses. Measurements were made at laboratory angles of 4 and 26° with flight paths ranging from 9 to 15 meters. The results obtained for the $O^{16}(d,n)F^{17}$ reaction differed from those reported previously at this laboratory. In particular, the levels in F^{17} at 3.03 and 4.74 Mev were not confirmed. Only two groups, corresponding to the ground and first excited (0.5 Mev) states in F^{17} were detected, even though a special effort was made to detect neutrons corresponding to the higher excited states. The results for the $C^{12}(d,n)N^{13}$ reaction generally confirmed the earlier measurements, although an excitation value of 3.58 ± 0.02 Mev was obtained for the unresolved $N^{13}_{2,3}$ group as compared with 3.75 ± 0.05 reported previously. Reaction Q-values of −1.11 ± 0.03, −2.86 ± 0.02, −3.57 ± 0.03, and −4.53 ± 0.04 Mev were measured for $Ca^{40}(d,n)Sc^{41}$ neutron groups, corresponding to levels in Sc^{41} at 0, 1.74, 2.46, and 3.41 Mev excitation. The first three values are in essential agreement with an earlier measurement, while the fourth group was not previously reported. The $Ca^{40}-Sc^{41}$ mass difference calculated from the ground state Q-value was also in agreement with results obtained using different methods. A comparison with the locations and intensities of the states in Ca^{41} suggests that the 1.74 and 2.46 Mev levels may be components of the $2p_{\frac{3}{2}}$ single particle state, and the 3.41 Mev level corresponds primarily to the $2p_{\frac{1}{2}}$ state. (Dissertation Abstr.)

38171 DIRECT INTERACTIONS AND NUCLEAR REACTION MECHANISMS. Proceedings of the Conference Held at the Institute of Physics of the University of Padua, September 3-8, 1962. E. Clementel and C. Villi, eds. Nuclear Physics. Volume 1. New York, Gordon and Breach, Science Publishers, 1963. 1239p. $39.50.

Progress in the field of direct interactions was discussed and the points of paramount importance that deserve further investigation were outlined. Information relating to nuclear structure, the generalized optical model, inelastic scattering, and compound nucleus processes obtained from direct interactions is presented. Other topics include direct and compound nuclear reactions from the point of view of time delay technique, stripping and pickup reactions, polarization in direct reactions, direct reactions between complex nuclei, direct reactions other than stripping, and direct reactions at high temperatures. Abstracts of several related papers and discussion of a number of the presented papers are also included. Separate abstracts are prepared for 140 of the 177 papers presented; the remaining papers were previously abstracted in NSA. (C.E.S.)

38172 DIRECT INTERACTIONS AND NUCLEAR STRUCTURE. M. H. Macfarlane (Univ. of Rochester, N. Y. and Argonne National Lab., Ill.). p.3-17 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Recent studies of various aspects of nuclear level structure are discussed. The extraction of nuclear matrix elements from stripping and pickup data, (p,n) reactions and isobaric analog states, single-particle states, single-hole states, and isobaric spin splittings, Coulomb stripping on Bi^{209} and the level structure of Bi^{210}, orbital angular momentum enhancement in (He^3,α) reactions, and single-particle states in the fp shell are considered. (C.E.S.)

38173 INFORMATION ON NUCLEAR STRUCTURE FROM (p,2p) AND (p,pd) REACTIONS. M. Riou (Faculté des Sciences, Orsay, France). p.18-32 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Information pertaining to proton binding energies and momentum distribution obtained from (p,2p) reactions and angular correlations in the reaction (p,pd) on Li^6 and Li^7 is presented. (C.E.S.)

38174 (p,2p) REACTIONS ON LIGHT NUCLEI. T. Berggren (Nordisk Institut for Teoretisk Atomfysik, Copenhagen) and G. Jacob. p.33-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Quasi-free proton-proton scattering on Li^6, Li^7, Be^9, B^{10}, B^{11}, and C^{12} is discussed. Experimental angular correlation distribution cross sections are compared to theoretical results from the impulse and WKB approximations. Parameters for the optical potential for B^{10} and B^{11} are also presented. (C.E.S.)

38175 PION CAPTURE AND NUCLEAR STRUCTURE. T. Ericson (CERN, Geneva). p.39-45 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The meson (π^-)-capture process that leads to the emission of two nucleons is explained, and nuclear structure data that can be obtained from this process are discussed. (C.E.S.)

38176 INVESTIGATION OF CORRELATIONS IN LIGHT NUCLEI BY MEANS OF FAST PION NUCLEAR INTERACTIONS. M. Jean (Faculté des Sciences, Orsay, France). p.46-50 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Reactions of the type (π^-,np), (π^-,2n), (π^+,2p), and (π^+,np) that give direct information on two-nucleon correlations are discussed. The $Li^6(\pi^+,2p)He^4$ reaction is used as an illustrative example. (C.E.S.)

38177 THE (d,t) REACTION ON Zr AND Mo ISOTOPES. V. I. Chuev and A. A. Ogloblin (Kurchatov Atomic Energy Inst., Moscow). p.51-5 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Triton energy spectra and angular distributions for the (d,t) reactions on zirconium-90, 91, 92, 94, and 96 and molybdenum-92, 94, 95, 96, 97, and 98 are presented. From the fact that the observed intensity variation with atomic mass is in good agreement with theoretical predictions, it is concluded that the Butler pick-up mechanism is predominant in the reaction. (C.E.S.)

38178 DIRECT REACTIONS IN THE SURFACE REGION. N. C. Francis, D. T. Goldman, and C. R. Lubitz

(Knolls Atomic Power Lab., Schenectady, N. Y.). p.56-7 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963. (TID-15953)

The incident nucleon reaction with a surface nucleon in nuclear reactions is described by means of an effective interaction. The effective interaction depends on the binding energy of the struck surface nucleon, kinetic energy of the incident nucleon, the nature of the isotopic spin of the particles, and the center of mass of the nucleon pair of the Coulomb energy is assumed to be an adiabatic parameter. Neutron-proton, neutron-neutron, and proton-proton interactions are discussed. (C.E.S.)

38179 SHELL STRUCTURE IN DIRECT INTERACTIONS AT THE NUCLEAR SURFACE. R. J. Griffiths (N.I.R.N.S., Harwell, Berks, Eng.), K. M. Knight, W. R. Gibson, and A. R. Johnston. p.58-61 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Particle binding energies and the structure of the nuclear surface were investigated by studying the summed energy spectra of the (p,2p) reaction on carbon. A 50-Mev proton beam incident on a polythene target was used. (C.E.S.)

38180 CLUSTER STRUCTURE AND DIRECT REACTION PROCESSES. E. Schmid, Y. C. Tang, and K. Wildermuth (Florida State Univ., Tallahassee). p.62-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

It is shown that the equivalence of different cluster wave functions has an important significance on direct nuclear reactions. The $Li^6(p,He^3)He^4$ reaction is used as an example. To discuss the behavior of the differential cross section in different angular regions a plane wave Born approximation is used. (C.E.S.)

38181 THE FOUNDATION OF THE OPTICAL MODEL. L. Rosenfeld (Nordisk Institut for Teoretisk Atomfysik, Copenhagen). p.69-79 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The limited equivalence between the optical model and the real nucleus is established in full generality independent of any detailed representation of the nucleus or of the nuclear forces. Since in the model each nucleon moves in a fixed potential the only requirement that can be directly imposed is the equality of the matrix elements for elastic scattering, which implies equality for the integrated total reaction cross sections. An explicit expression for the effective complex potential of the optical model is derived in terms of the actual interaction occurring in the determination of the model matrix element. (C.E.S.)

38182 THE DISTORTED WAVES THEORY OF DIRECT NUCLEAR REACTIONS. G. R. Satchler (Oak Ridge National Lab., Tenn.). p.80-93 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

General features of the distorted waves theory of direct nuclear reactions are outlined and elastic and inelastic scattering experiments that seem to indicate its validity are discussed. Rearrangement collisions such as deuteron stripping reactions in which the validity of the method is not quite clear are also considered. (C.E.S.)

38183 THE RELATIONSHIP BETWEEN DIRECT INTERACTIONS AND THE OPTICAL MODEL. I. E. McCarthy (Univ. of Adelaide). p.94-102 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Localization of the region of interaction, which is the most important limiting effect of the optical model wave functions, is discussed. A brief description of how localization comes about in the wave functions is presented. The scattering of 30-Mev neutrons on carbon-12 is used as an illustrative example. (C.E.S.)

38184 OPTICAL POTENTIALS FOR DISTORTED WAVE ANALYSES. P. E. Hodgson (Oxford Univ.). p.103-24 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Elastic scattering reactions for nucleons, deuterons, tritons, helium-3, and alpha particles in the 5 to 50 Mev region are analyzed to obtain data on the complex nuclear optical potentials used in the distorted wave Born approximation. (C.E.S.)

38185 THE OPTICAL MODEL WITH NONLOCAL POTENTIALS. F. G. Perey (Oak Ridge National Lab., Tenn.). p.125-38 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The relation between the nonlocal potential and the equivalent local optical potential is illustrated for neutron scattering on iron and lead nuclei. Systematic local proton analyses for several different energies and nuclei are also presented. (C.E.S.)

38186 A SOLUBLE THREE-BODY PROBLEM. A. Baz (Kurchatov Atomic Energy Inst., Moscow). p.143-6 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Equations are derived for the interaction of two particles with the potential field of a third particle. The three-body bound state problem for the scattering of deuterons on a potential field is also considered. (C.E.S.)

38187 DEUTERON REACTIONS IN NUCLEAR SPECTROSCOPY. O. F. Nemets (Ukrainian Academy of Sciences, Kiev). p.147-51 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The application of deuteron stripping reactions (d,p) in nuclear spectroscopy is considered. The differential cross section, dependence of the angular distribution maximum position on the magnitude of the angular momentum transferred, the interaction radius, and dependence of the angular distribution shape on mass number of angular momentum $l_n = 0$ transitions at 13.6 Mev deuteron energy are discussed. (C.E.S.)

38188 CHARGE-EXCHANGE "ELASTIC" SCATTERING BETWEEN MIRROR STATES. R. H. Bassel, R. M. Drisko, and G. R. Satchler (Oak Ridge National Lab., Tenn.). p.152-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The second term of the distorted-wave calculations for the charge-exchange quasi-elastic scattering of protons and He^3 on a nuclear model in which the state excited is the isobaric analog of the target ground state was discussed. The reactions considered were $V^{51}(p,n)$ at 12.1 Mev and $Fe^{56}(He^3,t)$ at 25 Mev. (C.E.S.)

38189 STRONG-COUPLING EFFECTS IN THE SCATTERING OF PROTONS FROM BERYLLIUM. M. R. Blieden and G. M. Temmer (Florida State Univ., Tallahassee). p.155-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Angular distributions and excitation functions for the elastic and inelastic scattering of 6.0-Mev protons on

beryllium-9 were investigated. The reaction was analyzed by means of a local optical model code and a strong-coupling code and the results were compared. (C.E.S.)

38190 OPTICAL MODEL FIT FOR d-Ni SCATTERING AT 21.6 Mev. K. W. Brockman, Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). p.159-61 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

An attempt is made to obtain optical model parameters for deuteron scattering from those for nucleon scattering. The data analyzed were from 21.6-Mev deuteron scattering on nickel; 9.4-Mev proton scattering on copper was used for comparison. (C.E.S.)

38191 THE OPE AND THE OPTICAL MODEL. J. Dabrowski (Universitet, Copenhagen). p.162-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

It is shown that the one pion exchange (OPE) model does not give a good approximation to the nucleon-nucleon scattering amplitude used to determine the optical model potential. (C.E.S.)

38192 OPTICAL MODEL ANALYSIS OF ELASTIC DEUTERON SCATTERING. E. C. Halbert, R. H. Bassel, and G. R. Satchler (Oak Ridge National Lab., Tenn.). p.167-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

An optical model program was used to find complex potentials fitting deuteron elastic scattering data at 11 and 11.8 Mev. A volume-absorption form and a surface-absorption form were used for the nuclear potential. A Coulomb potential, from uniform charge distribution of radius 1.3 $A^{\frac{1}{3}}$ f, was added in each case. The best fits obtained were illustrated. (C.E.S.)

38193 PROTON REACTION CROSS SECTION AT 10 Mev. G. Igo and B. Wilkins (Univ. of California, Berkeley). p.173-6 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The applicability of the optical model for determining reaction cross sections for proton elastic scattering at 10 Mev is discussed. It is shown that an optical model analysis that uses a volume absorption potential of the same shape and radius of the Wood-Saxon potential predicts a range of reaction cross sections the upper limit of which nears the experimental results. A surface absorption potential that reaches a maximum at the half value radius of the real potential can be adjusted to fit the elastic scattering data and also to fit the trend of the reaction cross section measurements. (C.E.S.)

38194 EXACT DISTORTED WAVE CALCULATIONS IN DIRECT INTERACTIONS. D. F. Jackson (Battersea Coll. of Tech., London). p.177-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Exact distorted wave calculations of the cross section for neutron scattering from the ground state to the first excited state of Li^6 at 90 Mev are presented. The distorted incident and scattered waves are obtained exactly by a partial wave analysis with a spin-independent optical potential. Results obtained from the WKB calculations are shown for comparison. (C.E.S.)

38195 A REALISTIC DISTORTED WAVE CALCULATION OF (p,2p) ANGULAR CORRELATION. K. L. Lim and I. E. McCarthy (Univ. of Adelaide). p.180-2 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Experimental and theoretical data for the (p,2p) angular correlations at 155 Mev are compared. The free particles are described by realistic distorted-wave calculations assuming that the reaction takes place over a finite volume of the nuclear surface. (C.E.S.)

38196 DIRECT CAPTURE OF SLOW NEUTRONS FOLLOWED BY M1 RADIATION. J. E. Lynn (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.183-5 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Computations were made over the mass number range $15 \leq A \leq 100$ using a Saxon-Woods potential to find the cross section for M1 transitions in slow neutron capture to an S-wave final state in a complex potential well model. The cross section equation for an M1 transition is presented. (C.E.S.)

38197 EFFECT OF COLLECTIVE VIBRATIONS ON THE OPTICAL MODEL. B. Margolis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.186-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

A derivation for the effect of collective vibrations on the S and p-wave neutron strength functions is presented in analytic form. It is shown that quadrupole oscillations have a marked effect while octupole oscillations are negligible. (C.E.S.)

38198 OPTICAL MODEL WAVE FUNCTIONS FOR PROTON SCATTERING. T. J. Menne (Univ. of California, Berkeley). p.189-91 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The dependence of optical model wave functions for inelastic proton scattering are formulated and interpreted explicitly in terms of optical model parameters. The nuclear radius, mean free path, the anisotropy parameter, and the magnitude and gaussian width of the wave function in the focal region are the parameters considered. (C.E.S.)

38199 INVESTIGATION OF OPTICAL MODEL SURFACE ABSORPTION BASED ON INTERMEDIATE ENERGY p–Cu DATA. J. Olkowsky, M. A. Melkanoff, and J. S. Nodvik (Centre d'Études Nucléaires, Saclay, France). p.192-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

An analysis of experimental data at 7-17 Mev was undertaken to determine the surface absorption of the optical model for the scattering of protons on an intermediate nucleus such as copper. The potential used in the analysis was the standard optical potential with gaussian surface absorption and included a real spin-orbit term of the Thomas form. Parameters yielding acceptable agreement with the experimental differential cross section and polarization were presented. (C.E.S.)

38200 NUCLEAR STRUCTURE AND THE OPTICAL MODEL. A. S. Reiner (Weizmann Inst. of Science, Rehovoth, Israel). p.195-7 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Green's function techniques for the determination of ground-state properties of nuclear matter were used to derive an expression for the optical potential. The approach, which is of a nonperturbative nature, leads to feasible results if specific three-particle correlations are neglected. (C.E.S.)

38201 THE ANALYSIS OF (p,n) REACTIONS AND THE DETERMINATION OF THE ISOSPIN POTENTIAL. J. R. Rook and P. E. Hodgson (Oxford Univ.). p.198-200 of "Direct Interactions and Nuclear Reactions Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Conditions under which the (p,n) cross section determines the value of the strengths of the isospin-dependent potential in the optical potential expression are investigated. The $N^{14}(p,n)$ and $V^{51}(p,n)$ reactions at 10 and 12.1 Mev, respectively, are considered. It is shown that the differential cross sections are proportional to the square of the isospin potential and that the strength of the isospin potential can only be reliably determined from (p,n) reactions if the bombarding energy is considerably larger than the Q-value and if the nucleus is spinless. (C.E.S.)

38202 LIMITATIONS OF THE DISTORTED WAVE THEORY. J. R. Rook and D. Mitra (Oxford Univ.). p.201-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The finite and zero range approximations of the distorted-wave calculations of the reaction $O^{16}(t,p)$ at 10 Mev are compared. It is shown that the effect of including finite range is to reduce the forward cross section by 20% and the backward cross section by 90% and that the neglect of range effects excludes the possibility of physically meaningful precise fit to experimental data. The predicted cross sections of stripping and knock-out distorted wave theories are compared to establish the reaction mechanism. (C.E.S.)

38203 OPTICAL POTENTIAL FOR SCATTERING OF DEUTERONS BY NUCLEI. M. Sano (Osaka Univ.). p.204-7 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Theoretical considerations of deuteron elastic scattering that illustrate the validity of the optical model are presented. Equations for the real and imaginary parts of the optical potential are derived. The shape of the real potential is given assuming uniform density distribution of the nucleons. The contributions to the imaginary part of the potential from the deuteron inelastic scattering and dissociation processes are also illustrated. (C.E.S.)

38204 AN EXPLANATION OF THE SUCCESS OF THE BORN APPROXIMATION FOR INELASTIC ALPHA PARTICLE SCATTERING. N. S. Wall (Universitet, Copenhagen). p.208-10 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

From a study of the elastic scattering particle wave shifts in the plane-wave Born approximation (PWBA), an attempt was made to discover the source of the success in fitting inelastic alpha scattering data by an inconsistent calculation. The parameters used in constructing the PWBA curve corresponding to 40-Mev alpha particles on Ni^{58} were illustrated. To obtain the agreement of the PWBA calculations with experiment it is seen that the essential ingredient was the use of the square well potential. (C.E.S.)

38205 DIRECT INTERACTIONS AND THE COMPOUND NUCLEUS. H. Feshbach (Massachusetts Inst. of Tech., Cambridge). p.215-26 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Considerations that underlie the concepts of direct interaction and the compound nucleus are examined to determine their mutual relations and to see how these change with increasing energy. The essential physical element that distinguishes direct from compound-nucleus reactions is the interaction lifetime, which is of the order of 10^{-22} sec for direct reactions and 10^{-14} sec for compound nucleus reactions. An incident nucleon is considered as it moves through the nucleus and qualitative results and conclusions with regard to direct and compound-nucleon mechanisms are formally derived. (C.E.S.)

38206 EXPERIMENTAL EVIDENCE FOR COMPOUND NUCLEAR STATISTICAL PROCESSES. D. Bodansky (Univ. of Washington, Seattle). p.230-44 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Situations in which the statistical model criteria are fulfilled for both the compound and residual nuclei and in which sufficient averaging occurs to dampen the Ericson fluctuations are considered. Reactions are studied in the light of the statistical model to determine the validity of the model. Nuclear level density and the transmission of particles through the nuclear surface are investigated. Emission spectra, yields, and angular distributions are considered, and attention is directed toward the intermediate mass region where charged particle evaporation yields are appreciable and where the most extensive experimental information is available concerning the statistical model. (C.E.S.)

38207 NUCLEAR REACTIONS WITH 6 Mev NEUTRONS AND THE COMPETITION BETWEEN DIRECT INTERACTIONS AND COMPOUND NUCLEAR FORMATION. K. K. Seth (Northwestern Univ., Evanston, Ill.). p.267-81 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

A time-of-flight technique was used for neutron energy determination to study the competition between the direct interaction and the compound nucleus reaction mechanisms for the inelastic scattering of 6-Mev neutrons. It is found that the direct interaction contribution is ≤ 5 per cent of the total, both when the final state in the residual nucleus is well resolved and when the final state consists of a large number of unresolved levels, and that the inverse compound nucleus formation cross section is not energy independent as is commonly assumed. (C.E.S.)

38208 ANGULAR AND ENERGY DISTRIBUTIONS OF NEUTRONS EMITTED IN BOMBARDMENTS WITH 42 Mev ALPHA PARTICLES. D. M. Drake, P. Axel, and I. Halpern (Univ. of Washington, Seattle). p.282-6 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy and angular distributions for (α,n) reactions with aluminum, cobalt, niobium, and gold at 42 Mev were investigated. It is shown that the rate of decrease of differential cross section with neutron energy is greatest for the heaviest targets, the anisotropies decrease with increasing A, there are departures from symmetry about 90°, and the anisotropy of the statistical compound-nuclear part of the spectrum does not show dependence on neutron energy. (C.E.S.)

38209 THE RELATIVE CONTRIBUTION OF EVAPORATION AND DIRECT PHOTOEFFECT IN PHOTONUCLEAR REACTIONS. R. M. Osokina (Lebedev Inst. of Physics, Moscow). p.297-304 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Measured photoproton yields from medium weight nuclei ($20 \leq Z \leq 60$) excited by bremsstrahlung with a maximum

energy of about 24 Mev and available (γ,n) and (γ,2n) cross sections were analyzed to establish the role of evaporation and direct photoeffect in photonuclear reactions at 15-25 Mev excitation energies. The contribution of evaporation in photoproton yields was evaluated by comparing the mean-weighted proton branching ratios predicted by statistical theory with ratios of the observed proton yields. (C.E.S.)

38210 EVIDENCE CONCERNING THE IMPORTANCE OF "DIRECT" OR "POTENTIAL" NEUTRON CAPTURE AT LOW ENERGIES. J. R. Bird (Atomic Energy Research Establishment, Harwell, Berks, Eng.), J. H. Gibbons, and W. M. Good. p.305-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Neutron-capture gamma spectra at 30 kev are compared with previous thermal neutron capture spectra. A markedly lower relative yield of high-energy gamma rays compared with thermal capture is observed that is in reasonable agreement with predictions for direct-capture cross sections. (C.E.S.)

38211 PARTIAL HEATING IN NUCLEAR REACTIONS. K. Izumo (Tokyo Univ.). p.312-17 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

An attempt is made to explain the intermediate resonances previously found in reaction total cross sections, excitation curves, and energy spectra by a concept in which only a few of the surface nucleons interact strongly with the incident particle while the inert core nucleons produce only an average potential for the incident particle. The nuclear temperatures in these reactions become larger than usual since only a few nucleons excite in this treatment. (C.E.S.)

38212 STATISTICAL MODEL CALCULATIONS OF NEUTRON INDUCED REACTIONS IN MEDIUM WEIGHT NUCLEI. G. S. Mani and M. A. Melkanoff (Centre d'Études Nucléaires, Saclay, France). p.318-21 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

An optical potential with a diffuse edge and optical model parameters obtained from elastic scattering data were used for a statistical analysis of neutron reactions (n,α) and (n,p) at 5-25 Mev. The statistical calculations of the cross sections for $23 \leq A \leq 77$ nuclei were presented. (C.E.S.)

38213 (n,2n) REACTION CROSS SECTIONS IN F^{19}, Cu^{63}, Cu^{65}, AND Zn^{64}. L. A. Rayburn Univ. of Georgia, Athens and Argonne National Lab., Ill.). p.322-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Theoretical values from statistical concepts of the compound nucleus model were compared with experimental values for the (n,2n) reaction cross sections in F^{19}, Cu^{63}, Cu^{65}, and Zn^{64} for incident energies of 12-20 Mev. (C.E.S.)

38214 NUCLEAR SUPERFLUIDITY AND PHASE TRANSITION. M. Sano and S. Yamasaki (Osaka Univ.). p.325-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The theory of superconductivity is applied to the thermodynamics of atomic nuclei. Fermi gas model parameters are used to obtain the relation between entropy and excitation energy, and the normal-superfluid transition temperature of atomic nuclei is expressed as a function of atomic mass. (C.E.S.)

38215 NUCLEAR SUPERFLUIDITY AND LEVEL DENSITY. M. Sano and S. Yamasaki (Osaka Univ.). p.330-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The thermodynamic properties of energy, entropy, and specific heat in nuclear superfluidity are used to obtain information on nuclear level density. The nuclear level density as a function of energy is presented, and it is shown that below the critical energy the level density is much smaller than that expected for normal states and that there is an increase in level density at the critical energy corresponding to the increase in specific heat. (C.E.S.)

38216 THEORETICAL DISCUSSION OF DIRECT INTERACTIONS AND COMPOUND NUCLEUS REACTIONS FROM THE POINT OF VIEW OF TIME DELAY. T. Ericson (CERN, Geneva). p. 343-51 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

An indirect method for measuring the time delay in direct and compound-nucleus reactions is discussed. The method determines the time delay from the fluctuation of the reaction cross section with energy. This method also provides a means to investigate the region of overlapping levels in the reactions. (C.E.S.)

38217 A BREMSSTRAHLUNG TECHNIQUE FOR MEASUREMENT OF TIME DELAY IN NUCLEAR REACTIONS. R. M. Eisberg (Univ. of California, Santa Barbara). p.352-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

A method for measuring the time delay in nuclear reactions that depends on the bremsstrahlung spectra is presented. In nuclear reactions there is a certain net amplitude for the emission of bremsstrahlung, one component of the amplitude arising from the cessation of the current associated with the incident particle and the other arising from the initiation of the current associated with the product particle. The time delay leads to a phase difference in the two components that will interfere coherently and can be determined from the bremsstrahlung spectra. (C.E.S.)

38218 PRELIMINARY RESULTS OF TIME DELAY MEASUREMENTS IN NUCLEAR REACTIONS USING THE BREMSSTRAHLUNG TECHNIQUE. L. F. Hansen (Univ. of California, Livermore). p.367-75 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

To measure time delay in proton scattering reactions a system was designed to detect the low energy γ rays with good resolution and in fast coincidence with the protons. The detection system was used in the C(p,pγ) reaction at 2.5–4.55 Mev, and a time delay measurement of the order of 10^{-20} sec was obtained. (C.E.S.)

38219 RESONANT TRANSFER AND THE MEASUREMENT OF SHORTTIME INTERVALS IN NUCLEAR REACTIONS. G. M. Temmer (Florida State Univ., Tallahassee). p.376-81 of "Direct Interactions and Nuclear Reactions Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Previous experiments on the resonant transfer of electrons between equivalent atomic sites in a hydrogen atom and a passing proton are used as the basis for a discussion of the transfer of a single nucleon or a cluster of nucleons between two identical nuclear sites. The alpha

reaction with Li^6 in which Li^6 is described as $He^4 + d$ is used as an example. It is concluded that if this effect could be observed experimentally it would provide a probe for exploring times of the order of 10^{-21} sec in nuclear reactions. (C.E.S.)

38220 A PROPOSAL OF USING K−X-RADIATION TO MEASURE THE LIFETIME OF THE COMPOUND NUCLEUS. P. C. Gugelot (Instituut voor Kernphysisch Onderzoek, Amsterdam). p.382-6 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

In (α,p) reactions with an element of atomic number Z the detection of (Z + 2) K−x rays emitted before the compound nucleus has had a chance to emit a proton is discussed as a method for measuring the lifetime of the compound nucleus. Since (Z + 2) K−x radiation must be detected in the presence of a large background of Z K−x rays the production cross section of K−x rays in (α,p) reactions at 52 Mev is given for various nuclei. (C.E.S.)

38221 STUDY OF THE $Si^{28}(n,\alpha)$ REACTION WITH 12.15−18.4 Mev NEUTRONS AND EXPERIMENTAL EVIDENCE OF THE ERICSON FLUCTUATIONS. L. Colli, I. Iori, M. G. Marcazzan, and M. Milazzo (CISE, Milan). p.387-93 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The $Si^{28}(n,\alpha)$ reaction was carried out at 12.15−18.4 Mev to investigate the statistical model predictions of strong fluctuations in the cross section when the energy resolution of the incident neutron is of the order of the total width of the compound nucleus. The cross section vs neutron energy curve is plotted, and the fluctuations are of the same order of magnitude as the predicted values. (C.E.S.)

38222 RECENT RESULTS ON STRIPPING AND PICK-UP REACTIONS. L. Colli (Università, Milan and CISE, Milan). p.397-412 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Compound nucleus formation effects in (d,p) reactions are discussed in the light of recent theories on evaporation. Angular distributions and experimental and theoretical cross sections are presented for several nuclei. (C.E.S.)

38223 A SOLUBLE MODEL FOR STRIPPING REACTIONS. A. Agodi and G. Papini (Università, Catania, Italy). p.413-19 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

A soluble model of stripping reactions in which the interaction gives rise to the vertices of the Butler approximation to direct reactions only is presented. Corrections to the Butler approximation that are due to an exact treatment of the vertices can be investigated without introducing any further interaction. (C.E.S.)

38224 STRIPPING AND POLOLOGY. J. P. F. Sellschop and D. W. Mingay (Univ. of Witwatersrand, Johannesburg). p.425-34 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The (d,p) stripping cross section term that contains the wave number (ikn) of the captured neutron in its final state and the momentum (q) with which the captured nucleon approaches the nuclear surface is shown to have a pole at a position corresponding to a momentum transfer $q^2 = -kn^2$, and small-Q reactions on Li^7 and B^{11} at 1−4 Mev are shown to be in agreement with predicted results. (C.E.S.)

38225 DOUBLE NUCLEAR STRIPPING. R. Middleton (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). p.435-56 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Available evidence on the mass-3 two-nucleon transfer reactions (t,p), (t,n), (He^3,p), and (He^3,n) strongly suggests that at energies in excess of about 5 or 6 Mev double stripping is the dominant mechanism. Angular distributions of the ground and excited-state nucleons are compared with double stripping calculations. (C.E.S.)

38226 REGGE POLES AND MULTIPARTICLE STRIPPING. R. D. Amado (Univ. of Pennsylvania, Philadelphia). p.465-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Regge pole theory is applied to the (p,t) reaction to produce a Born approximation for the multiparticle stripping process that accounts for the coherent exchange, with or without a bound state of the di-neutron lump, and makes predictions about the way the exchanged lump behaves off the energy shell. (C.E.S.)

38227 EXCHANGE EFFECTS IN DIRECT REACTIONS. S. Edwards (Florida State Univ., Tallahassee). p.469-79 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The magnitude of the contribution from the exchange model relative to that from the direct reaction model is given for the $F^{19}(p,\alpha)O^{16}$ reactions at 5.0−11.0 Mev. Plane-wave Born approximation fits for the angular distributions in these reactions are also presented. Distorted-wave Born approximation single-mode fits for the angular distributions from the $Be^9(p,\alpha)Li^6$ reaction showing backward peaking resulting from distortions are also illustrated. (C.E.S.)

38228 NUCLEON TRANSFER REACTIONS. G. Breit (Yale Univ., New Haven). p.480-98 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The nucleon transfer reaction $N^{14}(N^{14}, N^{13})N^{15}$ is discussed. A formulation of the theory that justifies the quantum mechanical effect estimates and the assumptions and approximations in the reaction is presented. The presentation is made in terms of a spinless neutron transferred between two spinless nuclei. (C.E.S.)

38229 (p,d) REACTIONS WITH 57 Mev PROTONS. K. Matsuda (Tokyo Univ.). p.499-506 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The angular distributions of (p,2p) and (p,d) reactions, which are used to investigate nucleon hole states of the nuclear shell structure, are compared. Characteristics of the (p,d) reaction spectra at 57 Mev are discussed with respect to the neutron binding energy. (C.E.S.)

38230 A COMPARISON OF (p,d), (p,t) AND (p,α) REACTIONS EXCITING THE SAME FINAL STATES. J. B. Ball, C. B. Fulmer, and C. D. Goodman (Oak Ridge National Lab., Tenn.). p.507-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

In order to single out the pick-up contributions of the (p,d), (p,t), and (p,α) reactions the set of reactions leading to the ground state of Zr^{89} using targets with one neutron, two neutrons, and a proton outside the Zr^{90} closed shell was investigated. It is assumed that the relation of the

target state and the final state is known from the shell model. The differential cross sections for the (p,d), (p,t), and (p,α) reactions are presented and are found to be in the ratio 100 : 27 : 2, respectively. (C.E.S.)

38231 THE APPLICATION OF HIGH RESOLUTION NEUTRON TIME OF FLIGHT SPECTROSCOPY TO THE STUDY OF (d,n) REACTIONS. A. T. G. Ferguson, N. Gale, G. C. Morrison, and R. E. White (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.510-16 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The higher levels excited in (d,n) reactions with Be^9, N^{15}, F^{19}, and Na^{23} at 2.5 and 3.0 Mev were investigated over a large range of Q-values as a test of stripping theory by means of high-resolution neutron time-of-flight spectroscopy. The angular distributions were also presented. (C.E.S.)

38232 (p,t) REACTIONS AT 40 Mev. G. Bassani, C. D. Kavaloski, and N. M. Hintz (Univ. of Minnesota, Minneapolis). p.517-19 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The (p,t) reaction mechanism was investigated by bombarding Ni^{58}, Mn^{55}, Fe^{56}, and Fe^{54} with a 40-Mev proton beam. The triton energy spectra and angular distributions were presented. (C.E.S.)

38233 ANALYSIS OF PICK-UP REACTIONS IN THE A = 90 REGION. R. H. Bassel, R. M. Drisko, and G. R. Satchler (Oak Ridge National Lab., Tenn.). p.520-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Distorted-wave analyses of (p,d) reactions with Zr^{91}, Zr^{92}, Nb^{93}, Zr^{94}, and Zr^{96} at 22.3 Mev are presented to determine spectroscopic information and to investigate the reaction mechanism. The optical parameters and angular distributions are also presented. (C.E.S.)

38234 (p,d) PICK-UP REACTIONS WITH 22 Mev PROTONS ON TARGETS NEAR N = 50. C. D. Goodman, J. B. Ball, and C. B. Fulmer (Oak Ridge National Lab., Tenn.). p.524-6 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy spectra for (p,d) reactions on Y^{89}, Zr^{90}, Zr^{91}, Zr^{92}, Zr^{94}, Zr^{96}, and Nb^{93} were measured for 22-Mev protons. The spectra characteristically show very few strongly excited levels, and these are interpretable in the j-j coupling shell model as neutron hole states. (C.E.S.)

38235 (p,t) DOUBLE PICK-UP REACTIONS WITH 22 Mev PROTONS. C. D. Goodman, J. B. Ball, and C. B. Fulmer (Oak Ridge National Lab., Tenn.). p.527-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The triton energy spectra for the Zr^{94}(p,t) reaction and the angular distributions of the Zr^{96}(p,t) reaction are used as illustrative examples of (p,t) reactions on Y^{89}, Zr^{90}, Zr^{91}, Zr^{92}, Zr^{94}, Zr^{96}, and Nb^{93} at 22 Mev. The triton spectra from each of the even neutron targets is characterized by a prominent peak at the triton energy for which the final nucleus is left in its ground state. This peak results from the pick-up of a pair of neutrons from the highest occupied shell model state in such a way that the remaining neutrons are coupled to zero angular momentum. The angular distributions for the triton groups are all essentially alike and are characterized by a deep minimum at an angle of about 22°. (C.E.S.)

38236 DISTORTED WAVE BORN APPROXIMATION FOR STRIPPING TO VIRTUAL LEVELS. R. Huby and J. R. Mines (Univ. of Liverpool). p.530-2 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The distorted-wave Born approximation (DWBA) for (d,p) stripping to virtual levels is presented. The DWBA matrix element is calculated in the same way as in the bound case except for replacement of the bound state wave function by a resonantly scattered one and the insertion of a convergence factor. There are further trivial steps of integrating over the width of the virtual level and averaging over the unobserved directions of the neutron momenta. (C.E.S.)

38237 THE Li^7(d,n)Be^8 REACTION AT E_D = 1 Mev. C. Milone (Università, Catania, Italy). p.536-41 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The neutron energy spectra of the Li^7(d,n)Be^8 reaction at 1 Mev were measured and seems to give support to the existence of Be^8 levels around 1.4, 2.1, 3.4, 4.2, 5.5, 6.5, and 7.5 Mev. (C.E.S.)

38238 DIRECT INTERACTION AND COMPOUND FORMATION IN THE REACTIONS Li^6(d,p) Li^7 AND Li^6(d,α)α. W. Pfeifer, V. Meyer, and H. H. Staub (Universitat, Zurich). p.542-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The Li^6(d,p)Li^7 and Li^6(d,α)He^4 reactions were investigated at 3.4 to 5.2 Mev. The angular distributions have no pronounced peaks and their strong energy dependence cannot be explained by a stripping mechanism. The reactions must therefore proceed via the compound nucleus Be^8. (C.E.S.)

38239 EXPERIMENTAL EVIDENCE OF SMALL-Q STRIPPING REACTIONS. J. P. F. Sellschop and D. W. Mingay (Univ. of Witwatersrand, Johannesburg). p.545-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The angular distributions were measured for the small-Q (d,p) stripping reactions on Li^7, C^{12}, and B^{11} at 1–4 Mev. Counter plots are given together with plots of the ratio of the area beneath the measured differential cross section to that for a normalized Butler curve as a function of deuteron energy. The plots illustrate the agreement between the experimental distributions and the Butler theory. The plots are characterized by a ratio of approximately unity for the lower energies with deterioration at higher energies. (C.E.S.)

38240 A STUDY OF THE Si^{28}(d,p)Si^{29} REACTION AT 7.5 Mev. R. E. White (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.549-52 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Proton groups corresponding to all known Si^{29} states below 7 Mev in the Si^{28}(d,p) reaction at 7.5 Mev were found, and angular distributions were obtained for most of them. Reduced widths were calculated and presented along with the angle at which the reduced width was evaluated, angular momentum values, and new spin assignments. (C.E.S.)

38241 ION-SOURCES OF POLARIZED PARTICLES AND REACTIONS WITH POLARIZED DEUTERONS. E. Baumgartner (Univ. of Basel). p.569-79 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The polarization of protons and deuterons is discussed, and diagrams for two ion sources used for the polarization of protons and deuterons are illustrated. The dependence of the cross section on azimuthal angle and the anisotropy of neutrons from the $T(d,n)He^4$ reaction induced by 0.1-Mev polarized deuterons are considered. (C.E.S.)

38242 POLARIZATION EFFECTS IN DIRECT PHOTONUCLEAR REACTIONS. J. Sawicki (Università, Bologna). p.596-608 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The polarization of photonucleons is discussed. Polarization curves for the neutrons and protons emitted in the $D(\gamma,n)p$ reaction at 9.3–80.4 Mev are presented. The polarization of neutrons in (γ,n) reactions with Be^9 and C^{13} at ~3 Mev is also illustrated. (C.E.S.)

38243 THE EFFECTS OF POLARIZED TARGETS IN DIRECT INTERACTIONS. L. J. B. Goldfarb (Univ. of Manchester, Eng.), and D. A. Bromley. p.609-13 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Equations are presented for the angular distribution of the reaction product and residual nucleus in direct reactions involving polarized targets. The spin and parity of the residual nucleus are also discussed. (C.E.S.)

38244 ON THE USE OF NUCLEAR TARGETS ORIENTED AT LOW TEMPERATURE. L. D. Roberts (Oak Ridge National Lab., Tenn.). p.614-16 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Problems connected with the use of oriented targets with a charged particle beam are summarized. Static methods of nuclear orientation that use electric magnetic hyperfine structure coupling or an external magnetic field as the orienting force and dynamic methods of nuclear orientation are discussed. (C.E.S.)

38245 PRELIMINARY MEASUREMENT OF C_{nn} BY SCATTERING OF POLARIZED BEAM BY POLARIZED TARGET. A. Abragam, M. Borghini, P. Catillon, J. Coustham, P. Roubeau, and J. Thirion (CEN, Saclay, France). p.617-18 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The spin correlation parameter for the interaction of polarized protons at 20 Mev is investigated and found to be -0.91 ± 0.05 between 60 and 90°. (C.E.S.)

38246 ASYMMETRIES OF PROTONS IN $C^{12}(d,p)C^{13}$ USING A POLARIZED DEUTERON BEAM. R. Beurtey, P. Darriulat, R. Maillard, A. Papineau, and J. Thirion (CEN, Saclay, France). p.619-21 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

A polarized deuteron beam of intensity 2×10^8 sec^{-1} was used to investigate proton asymmetries in the $C^{12}(d,p)C^{13}$ reaction at 22 Mev. Asymmetries were presented for proton groups corresponding to the ground and 3.09-Mev level of C^{13}. (C.E.S.)

38247 PREDICTION OF DEUTERON POLARIZATION. K. W. Brockman, Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). p.622-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Theoretical calculations were undertaken to determine the relation between the polarization and cross section systematics and the size of the scattering angle for polarization values large enough to make a double scattering experiment feasible. Only central and spin orbit interactions were considered. The ratio of cross section to Rutherford cross section and vector and tensor polarizations for 21.6-Mev deuteron scattering on nickel are presented. The optical model was used for the calculations. (C.E.S.)

38248 POLARIZATION MEASUREMENTS OF PROTONS FROM (d,p) REACTIONS. J. X. Saladin and L. H. Reber (Univ. of Pittsburg). p.625-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The angular dependence of the proton polarization and the differential cross sections for (d,p) reactions on C^{12}, Mg^{24}, and Be^9 at 15 Mev were presented. Protons corresponding to the C^{13} 3.09-Mev level, the Mg^{25} ground state and 0.58-Mev level, and Be^{10} ground state were investigated. (C.E.S.)

38249 PROTON POLARIZATION STUDIES IN $C^{12}(d,p)C^{13}$ AND $O^{16}(d,p)O^{17}$ REACTIONS. E. Almqvist, J. E. Evans, and J. A. Kuehner (National Research Council of Canada, Chalk River, Ont.). p.629-32 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy dependence of both the differential cross sections and the polarizations from the $C^{12}(d,p)C^{13}$ reaction were measured at 5–12 Mev and show fluctuations near 6 and 9 Mev, suggesting compound nucleus formation. In contrast the polarization angular distributions for $O^{16}(d,p)O^{17}$ reactions at 7–10 Mev are independent of the bombarding energy and suggest that the polarization is associated with the stripping mechanism. (C.E.S.)

38250 POLARIZATION OF TRITONS IN THE REACTION $Li^6(n,\alpha)T^3$. H. Waeffler and G. Walch (Max-Planck Inst. for Chemistry, Mainz). p.633-5 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Triton polarization was measured for the $Li^6(n,\alpha)$ reaction at 255 kev. The observed angular distribution of the tritons was fitted by assuming a p-wave resonance of total angular momentum $J = 3/2$ together with a nonresonant s-wave. (C.E.S.)

38251 EFFECT OF VARIATION OF OPTICAL MODEL PARAMETERS ON POLARIZATIONS AND ANGULAR DISTRIBUTIONS IN DEUTERON STRIPPING PROCESSES. L. J. B. Goldfarb and M. B. Hooper (Univ. of Manchester, Eng.). p.636-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The orbital angular momentum $l = 0$ ground-state transition $Si^{28}(d,p)Si^{29}$ reaction at 15 Mev was studied to test the sensitivity of the results to the various optical-model parameters for each channel. The cross section fluctuations and proton polarization angular distributions are presented. (C.E.S.)

38252 MEASUREMENT OF PROTON POLARIZATION IN DEUTERON STRIPPING ON Be^9, B^{10}, C^{12} AND Ca^{40}. E. Boschitz (Lewis Research Center, Cleveland). p.640-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The proton polarization was measured for the $Be^9(d,p)$ ground and first-excited state and B^{10}, C^{12}, and Ca^{40} ground state reactions at 21 Mev. The polarizations and angular distributions were presented. (C.E.S.)

38253 POLARIZATION OF THE $Li^7(d,n)Be^8$ NEUTRONS. F. L. Hereford and S. V. Topp (Univ. of Virginia, Charlottesville). p.645-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The angular distribution of the ground state neutron group from the $Li^7(d,n)Be^8$ reaction was measured at bombarding energies of 0.68 and 2.0 Mev. It is concluded that both stripping and compound nucleus formation contributed to the reaction. The polarization of the neutrons was also measured at several angles of emission. (C.E.S.)

38254 CALCULATIONS OF POLARIZATION IN S-WAVE CAPTURE STRIPPING REACTIONS. D. Robson (Univ. of Melbourne, Victoria, Australia). p.654-6 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Exact numerical calculations for s-wave captures in the $Si^{28}(d,p)Si^{29}$ reaction show that the polarization arising from deuteron spin-orbit distortion alone and the polarization arising from proton spin-orbit alone are similar and approximately additive. (C.E.S.)

38255 POLARIZATION IN PROTON-CARBON ELASTIC SCATTERING. J. Sanada, K. Nishimura, I. Hayashi, N. Ryu, H. Hasai, D. C. Worth, H. Imada, K. Fukunaga, B. N. Sung, and Y. Hiratate (Tokyo Univ.). p.657-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The angular distributions of the polarization in proton elastic scattering on C^{12} at 10.8 and 12.7 Mev are presented. A contour map of the polarization is also illustrated. (C.E.S.)

38256 PROTON POLARIZATION ON THE REACTION $C^{12}(d,p)C^{13}$ FOR DEUTERON ENERGIES BELOW 1.3 Mev. C. Weddigen (Technische Hochschule, Karlsruhe, Ger.). p.660-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy dependence of the polarization was measured for the $C^{12}(d,p)C^{13}$ reaction at a fixed angle of 52° over the deuteron energy range of 0.9–1.3 Mev. The azimuthal anisotropy perpendicular to the proton polarization as a function of proton energy was also measured at a deuteron energy of 1.04 Mev and at the same angle. (C.E.S.)

38257 INELASTIC EXCITATION OF COLLECTIVE MODES. J. S. Blair (Inst. for Theoretical Physics, Copenhagen and Univ. of Washington, Seattle). p.669-94 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Inelastic scattering in which collective surface excitations occur is discussed. The extended optical model is used to compare the distorted wave and adiabatic approximations for the single excitation cross sections for alpha particles on even-even nuclei. Alpha inelastic scattering on Ni^{58}, Fe^{56}, and Zr^{90} at 43 Mev is discussed. (C.E.S.)

38258 GAMMA RAY ANGULAR CORRELATIONS FROM DIRECT NUCLEAR REACTIONS. R. M. Williamson (Duke Univ., Durham, N. C.). p.695-705 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The angular correlation of gamma rays measured in coincidence with the product nucleon following deuteron stripping is discussed as a method for investigating nuclear structure. The related behavior of direct interaction angular correlations are considered for several (d,n) and (d,p) reactions. (C.E.S.)

38259 THE INELASTIC SCATTERING OF DEUTERONS. O. F. Nemets, Yu. V. Gofman, and V. V. Tokarevsky (Ukrainian Academy of Sciences, Kiev). p.706-10 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The differential cross sections for the inelastic scattering of 13.6-Mev deuterons on Si^{28}, Ti^{48}, Cr^{50}, Cr^{52}, Cr^{54}, Fe^{56}, Ni^{58}, Ni^{60}, Ni^{62}, Ni^{64}, Zn^{64}, Zn^{68}, Zn^{70}, and Sn^{116} are presented. (C.E.S.)

38260 INELASTIC ELECTRON SCATTERING AT HIGH ENERGIES AND NUCLEAR STRUCTURE (EXPERIMENTAL). H. W. Kendall (Massachusetts Inst. of Tech., Cambridge). p.711-19 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy spectra for electron inelastic scattering on odd-A nuclei at 183-600 Mev were investigated to determine the effect of the valence nucleons in modifying the core collective states. Comparisons of the electron spectra with similar spectra from one or more of the heavy particle reactions (p,p'), (n,n'), (d,d'), or (α,α') were made for Cu^{63}, In^{115}, Ta^{181}, Pb^{208}, Au^{197}, and Bi^{209}. The strong collective states were observed to be split into multiplets as a consequence of the valence nucleon-core interaction. (C.E.S.)

38261 INELASTIC ELECTRON SCATTERING AT HIGH ENERGIES AND NUCLEAR STRUCTURE (THEORETICAL). K. Gottfried (Harvard Univ., Cambridge, Mass.). p.720-33 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The inelastic scattering of electrons at high energies is discussed theoretically with emphasis on nuclear structure data that can be obtained by this method. The nucleus is treated non-relativistically. Formulas for the inelastic cross sections summed over the excited states of the target and their sensitivity to correlations in the nuclear ground state are considered. Scattering with energy loss small compared to the Fermi energy that excites discrete energy levels is also discussed. (C.E.S.)

38262 EXCITATION OF COLLECTIVE STATES BY INELASTIC ELECTRON SCATTERING. G. R. Bishop (Faculté des Sciences, Orsay, France). p.734-49 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Analysis of the data obtained from the excitation of nuclear levels by the inelastic scattering of high energy electrons is discussed with respect to the properties of these excited states such as spin, parity, and the structure of the transition operators between them and the nuclear ground state. It is shown that the Born approximation is a reasonable tool for analyzing the inelastic scattering from lighter nuclei provided that large angle scattering is not included. Inelastic scattering data from O^{16}, S^{32}, and Al^{27} are analyzed. (C.E.S.)

38263 STUDIES ON COLLECTIVE STATES IN C^{12}. G. T. Garvey (Yale Univ., New Haven). p.750-60 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The collective characteristics of a number of states in C^{12} are discussed. The energy level diagram of C^{12} is shown and energy spectra and angular distributions from C^{12} inelastic scattering on C^{12} are illustrated. Experimental data are compared to the Born approximation and collective model predictions. Angular distributions of the alpha particle from the decay of the C^{12} 14.05-Mev level to the Be^8 ground state are also shown. (C.E.S.)

38264 ELECTRON SCATTERING STUDY OF NUCLEAR LEVELS OF Ca^{40}. D. Blum, P. Barreau, and J. Bellicard (CEN, Saclay, France). p.761-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Measurements were carried out with 120, 150, 180, and 220-Mev electrons to search for odd multipole states of Ca^{40} by inelastic scattering. The reduced transition probabilities are given for E3 and E5 states found. Spin, parity, and reduced transition probabilities are also given for the Ca^{40} energy levels from 3.73 to 8.50 Mev. (C.E.S.)

38265 EXCITATION OF VIBRATIONAL LEVELS IN Fe^{54} BY INELASTIC SCATTERING OF 43 Mev PARTICLES. M. Barloutaud, R. Chaminade, H. Faraggi, D. Garreta, and B. G. Harvey (CEN, Saclay, France). p.765-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The differential cross section curves for alpha and electron inelastic scattering on Fe^{54} at 43 Mev are presented. The energies, parities, and spins of the vibrational levels excited in the scattering experiment are compared with predictions of the Blair-Drozdov model. (C.E.S.)

38266 COLLECTIVE LEVELS IN 11 ISOTOPES OF Ti, Ni, AND Zn. H. W. Broek and J. L. Yntema (Argonne National Lab., Ill.). p.769-71 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy spectra and angular distributions of alpha particles inelastically scattered on Ni^{62} at 43 Mev are used as examples in discussing the collective states of Ni^{58}, Ni^{60}, Ni^{62}, Zn^{64}, Zn^{66}, Zn^{68}, Ti^{46}, Ti^{47}, Ti^{48}, Ti^{49}, and Ti^{50}. (C.E.S.)

38267 INVESTIGATION OF ANGULAR CORRELATION BETWEEN A NEUTRON AND A γ-PHOTON IN INELASTIC SCATTERING OF 14 Mev NEUTRONS. B. A. Benetskij and I. M. Frank (Lebedev Inst. of Physics, Moscow). p.781-5 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Angular correlation measurements between the neutron and gamma ray in neutron inelastic scattering on C^{12} at 14 Mev are presented. The data are compared with similar measurements for proton inelastic scattering. (C.E.S.)

38268 COLLECTIVE STATES IN THE EVEN ISOTOPES OF SELENIUM. W. Darcey, D. J. Pullen, and N. W. Tanner (Oxford Univ. and Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). p.795-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy levels in Se^{76}, Se^{78}, and Se^{80} obtained from proton inelastic scattering at 12 Mev are presented. Angular distributions for strongly excited states in the $Se^{76}(p,p')$ reaction are shown as characteristic of the three reactions. It is concluded that although proton inelastic scattering with its inherent high resolution is well suited to locate the near degenerate vibrational triplets, the reaction mechanism is not sufficiently clear to extract spin assignments from the differential cross sections. (C.E.S.)

38269 ENERGY SPECTRA OF PHOTONEUTRONS FROM DIRECT INTERACTIONS IN C^{12} AND O^{16}. F. W. K. Firk, K. H. Lokan, and E. M. Bower (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.804-6 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy spectra and cross sections of the (γ,n) reactions in C^{12} and O^{16} at 15-33 Mev are presented. The energy levels excited in these reactions are discussed. (C.E.S.)

38270 ENERGY SPECTRA OF PHOTONEUTRONS FROM CALCIUM AND SULPHUR. F. W. K. Firk and E. R. Rae (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.807-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy spectra of photoneutrons from Ca^{40} and S^{32} produced by 32-Mev bremsstrahlung are presented. The relative yield of ground-state gamma rays from the (p,γ) reaction with K^{39} and P^{31} are also shown for comparison. (C.E.S.)

38271 ANGULAR DISTRIBUTION FROM INELASTIC DEUTERON SCATTERING. B. K. Jolly, E. K. Lin, and B. L. Cohen (Univ. of Pittsburgh). p.813-16 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The angular distributions for deuteron inelastic scattering on Ni^{58}, Ni^{60}, Ni^{62}, Zr^{90}, Zr^{92}, Zr^{94}, Sn^{116}, Sn^{118}, Sn^{120}, and Sn^{124} at 15 Mev are presented. It is concluded that some process other than the excitation of collective modes contributes to the reaction since the angular distributions from states of a given spin and parity are not the same. (C.E.S.)

38272 DIRECT INTERACTION IN THE PHOTONEUTRON EMISSION FROM SULPHUR. C. Milone (Università, Catania, Italy), S. Milone Tamburino, V. Emma, S. Femino' and S. Jannelli. p.817-20 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy spectra of the photoneutrons from S^{32} are discussed in terms of the (γ,n) and (γ,np) reactions with 30-Mev bremsstrahlung. About 85% of the neutrons are due to the (γ,n) reaction and 15% to the (γ,np) reaction. In the (γ,np) reaction a large fraction of the neutrons is emitted by direct interaction. (C.E.S.)

38273 $p' - \gamma$ ANGULAR CORRELATION OF $C^{12}(p,p')C^{12*}$ (Q = −4.43 Mev). Y. Nagahara, N. Yamamuro, R. Kajikawa, N. Takano, S. Kobayashi, and K. Matsuda (Tokyo Univ.). p.821-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The angular correlations between the inelastically scattered protons from C^{12}(Q = −4.43 Mev) and the associated gammas were investigated at proton energies of 9.9, 10.5, 11.0, 12.0, 13.0, and 14.6 Mev. Parameters for the angular correlation theoretical formula were presented at each energy for angles of 32, 60, 88, 120, and 148°. The correlation shows a direct-reaction type pattern. (C.E.S.)

38274 INELASTIC SCATTERING OF 12.8 Mev DEUTERONS ON Al^{27} NUCLEI. H. Niewodniczanski, J. Nurzynski, and J. Wilczynski (Inst. of Nuclear Physics, Krakow). p.824-7 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The differential cross sections for the inelastic scattering of deuterons on Al^{27} leading to several excited states were measured at 12.8 Mev in order to investigate possible differences in the shape of angular distributions for the cases when the single particle or collective states are excited. The results were interpreted in terms of diffraction and plane-wave theories. No marked difference in angular distributions were observed between excitations to single particle states and rotational ones. (C.E.S.)

38275 $n' - \gamma$ ANGULAR CORRELATION FOR INELASTIC NEUTRON SCATTERING. T. Niewodniczanski and M. P. Steiger (Eidgenössische Technische Hochschule, Zurich). p.828-31 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The neutron angular correlations with the associated gammas in neutron inelastic scattering on Mg^{24} and Fe^{56} were measured at 3.5 and 2.0 Mev, respectively. The results show approximate agreement in shape with the theoretical curves based on the statistical model of compound nucleus formation. (C.E.S.)

38276 ANALYSIS OF ANGULAR CORRELATION FOR INELASTIC PROTON SCATTERING ON Fe^{56} AND Ni^{58}. G. R. Satchler (Oak Ridge National Lab., Tenn.) and E. Sheldon. p.832-7 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The contributions of compound nucleus (CN) and direct interaction (DI) mechanisms in the inelastic proton scattering on Fe^{56} and Ni^{58} were investigated. The p-γ angular correlations for $Fe^{56}(p,p'\gamma)$ at 4.22 Mev were compared with predictions of statistical CN theory. The angular correlations for the $Ni^{58}(p,p'\gamma)$ reaction at 5.73 Mev were compared with the pure CN mechanism and combined CN plus DI mechanisms. (C.E.S.)

38277 INELASTIC SCATTERING TO THE FIRST EXCITED STATE OF THE EVEN-EVEN NUCLEI. A. P. Stamp (Clarendon Lab., Oxford). p.838-41 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The inelastic scattering resulting from the excitation of the first 2^+ states of even-even nuclei is investigated. The nuclei are assumed to be axially symmetric and to have the dynamics of a rigid rotation. Optical and rotational model predictions are compared with experimental proton elastic and inelastic differential cross sections for Ne^{20} at 14.2 Mev and deuteron elastic and inelastic cross sections for Mg^{24} at 11.8 Mev. (C.E.S.)

38278 EXCITATION OF THE NUCLEAR GIANT RESONANCE IN O^{16} AND B^{11} BY (d,γ) REACTIONS. M. Suffert, G. Costa, and D. Magnac-Valette (Centre de Recherches, Strasbourg). p.842-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The $Be^9(d,\gamma)B^{11}$ and $N^{14}(d,\gamma)O^{16}$ reactions were investigated in the energy regions 16-20 and 21.4-25.0 Mev, respectively. The differential cross sections were measured at 90° for the ground-state transitions. The differential cross sections reach a maximum of 0.55 μb/sterad at 16.9-Mev excitation energy in B^{11} and 22.7-Mev excitation energy in O^{16}. (C.E.S.)

38279 REACTIONS IN THE NUCLEAR SURFACE. A. Zucker (Oak Ridge National Lab., Tenn.). p.857-68 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Heavy ion induced reactions for exploring the nuclear surface are discussed. Single-nucleon tunneling, complex transfers involving many particles, break-up collisions, and cluster transfers are considered. Cross sections, angular distributions, and energy spectra are illustrated. (C.E.S.)

38280 CLUSTER DISSOCIATION STUDIES. G. C. Phillips (Rice Univ., Houston, Tex.). p.869-77 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Experimental evidence on the dissociation of nuclei into two or more clusters of nucleons is reviewed. Light element reactions and heavy-ion-induced reactions are considered. The partial widths of states, reaction cross sections for cluster exchange, and many-particle break-up reactions are discussed. It is concluded that the strength of nuclear reactions can at least be qualitatively predicted by the cluster model and that calculations with the independent particle model will ultimately provide a more quantitative method of estimating the decay properties of nuclear states and deducing the cluster configurations. (C.E.S.)

38281 NUCLEAR REACTION STUDIES WITH LITHIUM IONS. G. C. Morrison (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.878-900 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Apparatus for the production of Li^6 and Li^7 ion beams and general features of lithium-induced reactions are discussed. Angular distributions, cross sections, and energy spectra are illustrated for the reactions (Li^6,α), (Li^6,d), (Li^6,γ), Li^6,p), Li^6,t), (Li^6,He^3), (Li^7,α), (Li^7,d), Li^7,γ), (Li^7,p), (Li^7,t), (Li^7,He^3), and (Li^7,He^4). (C.E.S.)

38282 EFFECT OF LARGE ANGULAR MOMENTA IN NUCLEAR REACTIONS INDUCED BY HEAVY IONS. G. N. Flerov and V. A. Karnaukhov ([Joint Inst. for Nuclear Research,] Dubna, USSR). p.901-15 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The effect of high angular momentum in heavy-ion-induced reactions that lead to complete or partial fusion of nuclei is discussed. The high angular momentum manifestations in all stages of the reaction including the effects on compound nucleus formation, the mechanism of its decay, the characteristics of the radiation, and the final reaction products are considered. Reactions illustrating these effects are also presented. (C.E.S.)

38283 NUCLEAR SPECTROSCOPY USING BEAMS OF COMPLEX NUCLEI. E. Almqvist (National Research Council of Canada, Chalk River, Ont.). p.916-40 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The two broad classes of spectroscopic measurements are discussed. One class of measurements, which includes spins, parities, excitation energies, lifetimes, and widths, require no knowledge of the reaction mechanism involved. A second class of spectroscopic measurements are those in which a knowledge of the interaction mechanism is required in order to deduce nuclear structure properties from experimental results. Coulomb excitation, fragmentation and deuteron transfer, kinematic recoil methods for determining the ratio of gamma-ray width to total width of the recoil nucleus, the Doppler shift attenuation method for lifetimes, angular distributions that determine spin-parity combination, special geometry triple correlations for spin determinations, states of the compound system, and inelastic scattering with complex nuclei are discussed. (C.E.S.)

38284 MULTIPLE COULOMB EXCITATION STUDIES. J. S. Greenberg, D. A. Bromley, E. Bishop, and G. Seaman (Yale Univ., New Haven). p.941-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Multiple Coulomb excitation of a number of even-even

and odd-even nuclei in the rare earth region was investigated with O^{16} ions at 65 Mev. The de-excitation gamma spectra are illustrated for several reactions. (C.E.S.)

38285 GAMMA RAYS FOLLOWING (α,xn) REACTIONS. H. Morinaga and P. C. Gugelot (Instituut voor Kernphysisch Onderzoek, Amsterdam). p.949-51 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The gamma spectra from $(\alpha,4n)$ reactions on Gd^{154}, Gd^{156}, Gd^{158}, and Gd^{160} were investigated at 52 Mev. The gamma spectrum of the $Gd^{160}(\alpha,4n)$ reaction is given as a characteristic example. The energy level structures of Dy^{154}, Dy^{156}, Dy^{158}, Dy^{160}, Dy^{162}, and Dy^{164} obtained from the de-excitation spectra are also presented. (C.E.S.)

38286 DIRECT INTERACTION IN REACTIONS BETWEEN HEAVY IONS AND U^{238}. T. Sikkeland and V. E. Viola, Jr. (Univ. of California, Berkeley). p.952-5 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

An experiment that gives conclusive evidence of the presence of direct interaction in heavy ion reactions is reported. The method consists of measuring the angular correlation between coincident pairs of fission fragments. He^4, C^{12}, O^{16}, and Ne^{20} ions with an energy of 10.4 Mev/nucleon were used to bombard U^{238}. (C.E.S.)

38287 THE He^3-H^3 REACTION WITH MIRROR NUCLEI. E. Bogart, S. Devons, and M. Tatcher (Columbia Univ., New York). p.960-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The (He^3H^3) reactions with Li^7 and Be^9 were investigated at energies up to 4.5 Mev. The variation of cross sections with energy was examined, and angular distributions were measured at several energies and for center-of-mass angles between 15 and 100°. The elastic scattering of He^3 by Li^7 and Be^9 was also investigated. (C.E.S.)

38288 MUTUAL EXCITATION IN $C^{12}-C^{12}$ SCATTERING AT 126 Mev. G. T. Garvey, A. M. Smith, J. C. Hiebert, and F. E. Steigert (Yale Univ., New Haven). p.967-70 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The elastic and inelastic scatterings of C^{12} on C^{12} at 126 Mev were investigated. It was determined that the angular distributions for scattering to the 4.43-Mev 2^+ first excited state of C^{12} are oscillatory in nature and out of phase, consistent with the Blair phase rule. Employing a Born approximation and assuming a square deformed well, the data were fitted with an interaction radius corresponding to $r = 1.38f$ and an effective well depth of 3.2 Mev. (C.E.S.)

38289 INVESTIGATION OF LIGHT ELEMENT ENERGY LEVELS BY TWO-NUCLEON TRANSFER REACTIONS. B. G. Harvey, J. Cerny, R. H. Pehl, E. Rivet, and W. W. True (Univ. of California, Berkeley). p.974-7 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The strong peaks in the deuteron spectra that correspond to energy levels of the residual nuclei in (α,d) reactions with C^{12}, N^{14}, N^{15}, and O^{16} were investigated at 47 Mev. The angular distributions of the deuterons corresponding to all these levels were quite similar. The energies, Q-values, and integrated cross sections for strong levels formed in the reactions were presented. (C.E.S.)

38290 CLUSTER DISSOCIATION REACTIONS. R. Ollerhead, C. Chasman, and D. A. Bromley (Yale Univ., New Haven). p.984-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Measurements using 10 Mev/nucleon Li^6, B^{10}, and B^{11} beams that provide support for the cluster description of these nuclei for a very simple, cluster-dissociation reaction mechanism are reported. The alpha and deuteron energy spectra from the disintegration of 63-Mev Li^6 on C^{12}, the Li^6 spectra from B^{10} reactions on C^{12} at 105 Mev, and the Li^7 spectra from B^{11} reactions on C^{12} at 115.5 Mev are illustrated. (C.E.S.)

38291 STABLE PRODUCT TRANSFER REACTIONS. M. Sachs, C. Chasman, and D. A. Bromley (Yale Univ., New Haven). p.987-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Measurements that take advantage of the fact that beta-stable Be^9 is also stable against neutron decay only in its ground state are reported. Structure observed in the energy spectra of the Be^9 reaction products necessarily corresponds to excitations in the exit channel of an assumed binary reaction. The Be^9 and Be^{10} energy spectra from B^{11} reactions on C^{12} at 115.5 Mev are compared. (C.E.S.)

38292 STUDY OF TRANSFER REACTIONS IN THE HEAVY ION INTERACTION WITH NUCLEI BY THE DELAYED NEUTRON ACTIVITY METHOD. V. V. Volkov, L. Pomorski, Ya. Tys, and G. N. Flerov (Joint Inst. for Nuclear Research, Moscow). p.994-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Nucleon transfer reactions were investigated by measurement of the delayed neutron activity of N^{17}. Targets of C, Al, Cu, and Ta were bombarded with N^{14}, N^{15}, O^{16}, Ne^{20}, and Ne^{22} ions. In all cases there was observed the production of delayed neutron activity with a half life in agreement with values for N^{17}. Effective cross sections for the reactions were presented. (C.E.S.)

38293 ALPHA PARTICLE AND PROTON EMISSION FROM HEAVY ION INDUCED REACTIONS. J. C. Watson, A. R. Quinton, and D. A. Bromley (Yale Univ., New Haven). p.1000-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Energy spectra and angular distributions were measured for alpha particles and protons from targets of C, Al, Ti, Cu, Mo, Rh, Ta, Pt, and Th bombarded with 1.47-Mev nitrogen ions. All the angular distributions are asymmetric about 90° at energies above the barrier, consistent with a reaction mechanism comprising an evaporation component leading to a symmetric angular distribution and a direct interaction component contributing a sharp forward peak. The minima in the differential cross sections occur at 90° for exit channel energies near the barrier and at larger angles with increasing exit channel energies, indicating that the direct interaction component extends to backward angles. (C.E.S.)

38294 DETAILED (p,α) REACTION STUDIES ON THE LIGHTER NUCLEI WITH THE FLORIDA STATE UNIVERSITY TANDEM ACCELERATOR. G. M. Temmer (Florida State Univ., Tallahassee). p.1013-24 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The (p,α) reactions with Li^6, Be^9, and F^{19} were investigated at 3-12 Mev. Experimental cross sections and excitation curves are compared with optical model fits and the

distorted wave Born approximation in an attempt to determine the reaction mechanisms. Total and differential cross sections for the $Li^6(p,He^3)$ reaction are presented. (C.E.S.)

38295 THE $N^{15}(p,\alpha)C^{12}$ REACTION. T. Mikumo (Tokyo Univ.). p.1046-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

A qualitative interpretation of the characteristics of the angular distributions for the alpha particles corresponding to the ground and first excited state of C^{12} in the $N^{15}(p,\alpha)$ reaction at 7-15 Mev is given. A perspective view of the angular distribution vs energy curves is presented to illustrate the differences discussed. (C.E.S.)

38296 (n,α) REACTIONS WITH 14 Mev NEUTRONS. U. Facchini, M. G. Marcazzan, F. Tonolini, and L. Zetta (Universita, Milan and CISE, Milan). p.1054-7 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy spectra for the (n,α) reactions on Ho^{165}, Lu^{175}, Ta^{181}, and Au^{197} at 14 Mev are presented. The energy range of the alpha particles is 15-22 Mev. (C.E.S.)

38297 NEUTRON ANGULAR DISTRIBUTIONS FROM THE $Be^9(\alpha,n)C^{12}$ REACTION AT 10-14 Mev. J. Kjellman and A. Nilsson (Research Inst. for National Defence and Nobel Inst. of Physics, Stockholm). p.1058-60 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Angular distributions to the ground and first excited state of C^{12} in the $Be^9(\alpha,n)$ reaction at 10-14 Mev were measured. The energy dependence of the distributions is quite moderate, and all distributions are peaked in the backward as well as in the forward direction. (C.E.S.)

38298 ANGULAR DISTRIBUTION OF NEUTRONS FROM $BE^9(\alpha,n)C^{12}$ AND $C^{13}(\alpha,n)O^{16}$. G. Deconninck, M. de Vroey, and J. P. Meulders (Universite, Louvain, Belg.). p.1061-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Neutron angular distributions from the ground and first excited state of C^{12} and the ground state of O^{16} in (α,n) reactions with Be^9 and C^{13} at 14-23 Mev are presented. (C.E.S.)

38299 A STUDY OF THE REACTION $Be^9(p,\alpha)Li^6$ AS A DIRECT PROCESS. M. R. Blieden, G. M. Temmer, and K. L. Warsh (Florida State Univ., Tallahassee). p.1064-7 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The $Be^9(p,\alpha)Li^6$ reaction was investigated at 3.5-12.0 Mev. The excitation functions for the alpha groups corresponding to Li^6 ground and first excited states are monotonically decreasing functions of energy. Angular distributions are illustrated and the total cross sections obtained from the curves are also monotonically decreasing functions of energy. (C.E.S.)

38300 SOME ASPECTS OF THE Be^8 QUESTION AND Li^7 + p INTERACTION. G. Calvi, S. Cavallaro, R. Potenza, and A. Rubbino (Universita, Catania, Italy). p.1068-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The $Li^7(p,\alpha)$ reaction was investigated to determine the energy levels in Be^8. Three new levels were found. (C.E.S.)

38301 THE TREATMENT OF MANY-BODY NUCL AR BREAK-UP AS A TIME SEQUENCE OF TWO-BODY REACTIONS. G. C. Phillips, J. Bronson, Jr., A. Pitts, A. C. L. Barnard, J. Weil, and T. A. Belote (Rice Univ., Houston, Tex.). p.1070-2 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The reactions $B^{11}(p,\alpha)Be^8$, $Be^8 \rightarrow 2\alpha$; $Be^9(p,d)Be^8$, $Be^8 \rightarrow 2\alpha$; $Be^9(p,pn)Be^8$; and $C^{12}(d,pn)C^{12}$ were investigated. The reactions result in at least three product particles and are treated by two alternate sequential two-body decay modes proceeding through a different intermediate nuclear state. The proton spectra of the $Be^9(p,pn)$ and $C^{12}(d,pn)$ reactions are illustrated. (C.E.S.)

38302 Si + n INTERACTIONS UP TO $E_n = 5.5$ Mev. R. Potenza, R. Ricamo, A. Rubbino, and D. Zubke (Universita, Catania, Italy). p.1073-5 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The energy spectra and cross sections for the $Si^{28}(n,p)$, $Si^{28}(n,\alpha)$, and $Si^{29}(n,\alpha)$ reaction at 1.0-5.5 Mev are presented. (C.E.S.)

38303 ON THE MECHANISM OF (α,p) AND (p,α) REACTIONS. I. B. Teplov (Moscow State Univ.). p.1076-8 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The angular distributions and excitation functions for (α,p) reactions on B^{10}, C^{12}, Si^{28} at 16-26 Mev and for the $F^{19}(p,\alpha)$ reaction at 5.1-6.5 Mev were analyzed to determine the reaction mechanisms. (C.E.S.)

38304 DIRECT INTERACTIONS IN THE 100-200 Mev REGION. L. R. B. Elton (Battersea Coll. of Tech., London). p.1093-1108 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Four main types of reactions in the 100-200 Mev range are discussed together with the nuclear structure information that may be obtained from them. Knock-out reactions (p,2p) and (p,pn), inelastic proton scattering, (p,n) reactions, and information on parentage, radiative transfers, target polarization, and rotational bands in the 1p-shell obtained from γ ray measurements in these reactions are considered. Characteristic reactions are presented. (C.E.S.)

38305 QUASI-FREE PROTON-PROTON SCATTERING IN LIGHT NUCLEI AT 450 Mev. H. Tyren, S. Kullander, and R. Ramachandran (Univ. of Chicago). p.1109-13 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

In order to obtain information on the tightly bound protons in nuclei quasi-free p-p scattering on Li^6, Li^7, Be^9, B^{10}, B^{11}, C^{12}, O^{16}, and Ca^{40} was carried out at 450 Mev. Energy spectra were measured, and the separation energies were given for the pronounced 1 s and 1 p peaks in the spectra. Angular correlations for the proton groups and elements were also presented. (C.E.S.)

38306 NUCLEAR REACTIONS AT VERY HIGH ENERGIES. A. E. Glassgold (Univ. of California, Berkeley). p.1114-33 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Nuclear reactions in the Bev range and beyond are discussed with respect to the nuclear structure data obtainable from them. It is concluded that phenomena associated with multiple scattering become important in this energy range. Neutron and proton total cross sections and (π^-,p) and (π^+,p) cross sections are discussed. The relation between high energy scattering and simple nuclear reactions

and scattering, incoherent scattering and plural quasi-elastic scattering, and deuteron production at high energies are also considered. (C.E.S.)

38307 QUASI-FREE PROTON-PROTON SCATTERING AT 185 Mev. G. Tibell, O. Sundberg, and U. Miklavzic (Uppsala Univ.). p.1134-40 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The (p,2p) reactions with Li^7 and Ca^{40} were investigated at 185 Mev. The angular correlation distributions for the p-proton in Li^7 were measured at 35, 41.5, and 48°. The peaks corresponding to the three least bound protons in Ca^{40} were separated and data were given on the binding energies and angular correlation distributions of these three groups of protons. (C.E.S.)

38308 PICK-UP REACTIONS $C^{12}(p,d)C^{11}$ AND $Be^9(p,d)Be^8$ AT 155 Mev AND THE STRUCTURE OF C^{12} AND Be^9 NUCLEI. D. Bachelier, M. Bernas, C. Detraz, J. Genin, J. Haag, and P. Radvanyl (Faculte des Sciences, Orsay, France). p.1141-4 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Angular distribution and energy spectra were presented for the (p,d) reaction with C^{12} and Be^9 at 155 Mev. The ground state structures of C^{12} and Be^9 were discussed with respect to the experimental data. (C.E.S.)

38309 INELASTIC SCATTERING OF 156 Mev PROTONS ON LIGHT NUCLEI. J. C. Jacmart, J. P. Garron, M. Riou, and C. Ruhla (Faculte des Sciences, Orsay, France). p.1145-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The differential cross sections for excited levels in Li^6, Li^7, Be^9, C^{12}, and Ca^{40} for inelastic proton scattering at 156 Mev were presented. (C.E.S.)

38310 COLLECTIVE EXCITATIONS IN (p,n) INTERACTION AT 138 Mev. A. Langford (Atomic Energy Research Establishment, Harwell, Berks, Eng.), P. H. Bowen, G. C. Cox, and R. A. J. Riddle. p.1150-3 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

The (p,n) reaction with carbon and vanadium was carried out at 138 Mev to investigate the collective modes excited. Differential cross sections were presented. (C.E.S.)

38311 (p,γ) CORRELATIONS IN THE EXCITATION OF THE 15.1 Mev LEVEL T = 1 OF C^{12} AND NUCLEON-NUCLEON SCATTERING MATRICES. X. de Bouard, Ph. Loncke, C. Marty, N. Marty, and B. Tatischeff (Faculté des Sciences, Orsay, France). p.1154-9 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.

Angular distributions of γ rays emitted in coincidence with inelastically scattered protons were measured in the excitation of the 15.1-Mev, spin-parity $J^p = 1^+$, isospin T = 1 level of C^{12}. An attempt was made to obtain experimental agreement for the excitation of a level with isospin flip $\Delta T = 1$ in which the difference of the triplet and singlet scattering matrix is involved. (C.E.S.)

Particle Accelerators

Refer also to abstract 37029.

38312 (CERN-63-19) INTERNATIONAL CONFERENCE ON SECTOR-FOCUSED CYCLOTRONS AND MESON FACTORIES, CERN, APRIL 23-26, 1963. F. T. Howard, ed. (Oak Ridge National Lab., Tenn.); and N. Vogt-Nilsen, ed. (European Organization for Nuclear Research, Geneva). 428p.

Sixty-four papers presented at the International Conference on Sector-Focused Cyclotrons and Meson Factories are given. Topics covered include operating characteristics of and experience with sector-focused cyclotrons, extraction experiments, physics of high-current machines, physics problems connected with the design of high-current machines, studies in orbit theory of sector-focused cyclotrons, design features of sector-focused cyclotrons, meson factories, and a catalog of isochronous cyclotrons as the appendix. Separate abstracts were prepared for 54 papers. Nine papers were previously abstracted for NSA. (M.C.G.)

38313 (CERN-63-19(p.1-7)) SURVEY OF OPERATING SECTOR-FOCUSED CYCLOTRONS. R. S. Livingston (Oak Ridge National Lab., Tenn.)

A summary of operating experience gained with sector-focused cyclotrons indicated that the achievement of isochronism was accomplished without too much difficulty and that operation is very stable with parameter settings very reproducible from day to day. Topics covered include: machines now in operation, isochronism and the setting of trimming coils, energy definition, microscopic duty cycle, negative ions, radioactivity and radiation, and variation of energy. (M.C.G.)

38314 (CERN-63-19(p.24-30)) THE RELATIVISTIC ISOCHRONOUS CYCLOTRON AT KARLSRUHE. H. Steimel (Allgemeine Elektrizitatsgesellschaft, Frankfurt am Main).

The design of the Karlsruhe relativistic isochronous cyclotron is described. The magnetic field structure is of the Thomas type with radial 60° sectors and a period of 120°. The acceleration system is housed in the valleys of the magnetic pole shoes. It consists of 3 star-connected quarter-wave resonators. The gap between the hills of the pole shoes is 8 cm. The periodicity of the acceleration system is 3 times the cyclotron frequency. Control and measuring systems are incorporated in the cyclotron. The Livingston-type ion source is located 2.4 cm from the center of the machine. Results of measurements made with the cyclotron are discussed. (M.C.G.)

38315 (CERN-63-19(p.39-42)) PRELIMINARY OPERATIONAL EXPERIENCE WITH THE UNIVERSITY OF MICHIGAN 83-INCH SECTOR-FOCUSED CYCLOTRON. W. C. Parkinson and R. S. Tickle (Michigan. Univ., Ann Arbor).

Results of operation of the University of Michigan 83-in. sector-focused cyclotron are discussed. The rf system of the cyclotron is a two-dee half-wave system using dee-stem insulators and two quarter-wave "silos" as resonators. The frequency can be tuned over the range from 6 to 16 Mc under full power by sliding shorting planes in each silo. The first internal beams of protons and deuterons were obtained in November 1962, with pulsed rf voltages and without gradient coils. After installation of the permanent power supplies, field measurements were made to determine the effects of the gradient coils. (M.C.G.)

38316 (CERN-63-19(p.43-7)) THE PHILIPS AVF PROTOTYPE CYCLOTRON. N. F. Verster, W. Baehler, A. J. J. Franken, J. Geel, H. L. Hagedoorn, P. Kramer, and J. Zwanenburg (Philips Gloeilampenfabricken, N. V. Forschungslaboratorium, Eindhoven, Netherlands).

An internal beam was obtained in the Philips AVF cyclotron and the properties agreed very well with the theoretical predictions. The beam was extracted with an efficiency

of about 30%. The ion source is of the Livingston type. The extraction system consists of two electrostatic channels, separated by the tubes of the ion source, and a magnetic channel. The resonant circuit (a quarter-wave system) consists of a concentric resonant line with a movable shorting plate, a coupling tank, and a set of four feedthrough insulators supporting the dee stem. The isochronous field is trimmed by 10 circular coils, the currents through which are determined by means of a least squares analysis computer program. (M.C.G.)

38317 (CERN-63-19(p.48-51)) BEAM EXTRACTION FROM SECTOR-FOCUSED CYCLOTRONS. J. A. Martin (Oak Ridge National Lab., Tenn.).

The designs of beam extraction systems for medium-energy cyclotrons are reviewed. It is shown that high-extraction efficiency is improved for any system by the achievement of small radial amplitudes at the center of the cyclotron. (M.C.G.)

38318 (CERN-63-19(p.52-8)) BEAM EXTRACTION FROM ANALOGUE II. J. A. Martin, F. M. Russell, E. G. Richardson, Jr., and H. L. Dickerson (Oak Ridge National Lab., Tenn.).

The Analogue was designed to duplicate, as far as possible, the orbit dynamics expected in the 810-Mev Mc^2 cyclotron. The system used to increase the turn separation in the Analogue is a modification of the Tuck, Teng, and LeCouteur scheme in which a naturally occurring resonance is used. An appropriate point for extraction in a high-energy cyclotron was found to be at $V_r = 2$, where there are exactly two radial oscillations per revolution. In an 8-sector cyclotron this is the cubic essential 8/4 resonance. To use this resonance effectively, the small amplitude stability must be destroyed. In addition an electrostatic force is provided to counteract the magnetic field. Using an electron injector instead of a filament source also improved beam extraction. (M.C.G.)

38319 (CERN-63-19(p.73-9)) OPERATION OF THE REGENERATIVE EXTRACTION SYSTEM ON THE UNIVERSITY OF BIRMINGHAM 40-INCH CYCLOTRON. H. Kim, G. H. MacKenzie, W. B. Powell, and P. J. Waterton (Birmingham. Univ., England).

A peeler-regenerator beam extraction system was developed for the University of Birmingham 40-in. cyclotron. In this system particles near the extraction radius enter the peeler and regenerator where they receive an outward deflection in the peeler and an inward deflection in the regenerator. This action causes them to penetrate further into the peeler and regenerator and then into the extraction system. The peeler and regenerator are electrostatic devices operating with negative and positive potentials respectively. They are located on either side of the deflector in the center of a hill and their main action begins at a radius of 17.6 in. Measurements obtained with 11-Mev deuterons at dee voltages between 28.5 and 21.5 kv are described. Peelers and regenerators can also be used in internal target work to spread the beam over a larger area. (M.C.G.)

38320 (CERN-63-19(p.80-4)) A MODIFIED REGENERATIVE EXTRACTION SYSTEM FOR A SYNCHRO-CYCLOTRON. G. T. de Kruiff and N. F. Verster (Philips Gloeilampenfabrieken, N. V. Forschungslaboratorium, Eindhoven, Netherlands).

To deflect a large fraction of the internal beam in synchrocyclotrons without using a field-reducing magnetic channel, a device called a "compressor" is proposed for use in the regenerative system. The compressor, giving a negative field bump, is placed 30° behind the regenerator in the direction of the circulating beam. The effect of the compressor on the regenerated beam is noticeable only during the last revolution. (M.C.G.)

38321 (CERN-63-19(p.85-92)) SECTOR-FOCUSED CYCLOTRONS FOR NUCLEAR PHYSICS RESEARCH. A. Zucker (Oak Ridge National Lab., Tenn.)

Research programs made possible by sector-focused cyclotrons in the 20 to 100 Mev range are discussed. Studies of direct nuclear reactions and collective and statistical models are described. (M.C.G.)

38322 (CERN-63-19(p.93-100)) PHYSICS OF MESON FACTORIES. G. Bernardini (European Organization for Nuclear Research, Geneva).

Sizes of accelerators and studies of weak and strong interactions of elementary particles are discussed. (M.C.G.)

38323 (CERN-63-19(p.101-6)) NEGATIVE ION ACCELERATION AND RELATED MEASUREMENTS. J. W. Verba, W. Kuendig, A. C. Paul, J. R. Richardson, and B. T. Wright (California. Univ., Los Angeles).

The energy gain per turn in negative ion acceleration was obtained as a function of the radius by measuring the flight time of a beam pulse from the ion source to a given radius. The negative-ion pulse was detected by measuring the current due to stripped electrons left on a 0.1-in. copper foil. The total cross section per atom of air for the stripping of electrons from negative hydrogen ions was measured in the energy range from 14 to 45 Mev. The loss of negative ions due to dissociation by the electric field was also investigated. A combination stripping and current probe was developed. (M.C.G.)

38324 (CERN-63-19(p.107-17)) POLARIZED PARTICLES IN CYCLOTRONS. J. Thirion (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay).

The development of polarized sources for cyclotrons is described. Formation of an atomic beam, magnetic separation of the atomic states, ionization of the atomic beam, and high-frequency transitions in low or high magnetic fields are discussed. The polarized deuteron source at Saclay is described and experiments with 22-Mev polarized deuterons are discussed. (M.C.G.)

38325 (CERN-63-19(p.118-26)) DEPOLARIZATION PROCESS IN SECTOR-FOCUSING CYCLOTRONS. T. K. Khoe and L. C. Teng (Argonne National Lab., Ill.).

An analytical treatment of the depolarization of a polarized beam of charged particles during acceleration in a circular accelerator is presented. The classical spin equation was used for this analysis. An orthogonal curvilinear coordinate system was employed. Numerical examples are included. (M.C.G.)

38326 (CERN-63-19(p.127-9)) CHARACTERISTICS OF THE CERN POLARIZED PROTON SOURCE. L. Dick, Ph. Levy, and J. Vermeulen (European Organization for Nuclear Research, Geneva).

The main characteristics of the CERN polarized proton source are: dissociation of H_2 by rf at low pressure, injection of H atoms into a quadrupole through a ring-shaped pyrex nozzle using mercury vapor pumps, and separation of the atomic states in a 6-m-long quadrupole with a magnetic field varying from 3400 to 150 gauss. The beam of polarized atomic hydrogen was directed to the center of a 4.5-Mev cyclotron, where it is ionized by a perpendicular beam of electrons. (M.C.G.)

38327 (CERN-63-19(p.130-7)) A REVIEW OF BEAM LAYOUTS AND EXPERIMENTAL FACILITIES FOR SECTOR-FOCUSED CYCLOTRONS. E. L. Kelly (California. Univ., Berkeley. Lawrence Radiation Lab.).

Medium-energy sector-focused cyclotron facilities are described. The University of Colorado, ORNL, University of Maryland, and Berkeley 88-in cyclotron plans for experimental facilities are discussed. (M.C.G.)

38328 (CERN-63-19(p.138-43)) EXPERIMENTAL FACILITIES AND RESOLUTION CAPABILITY OF THE MSU CYCLOTRON. H. G. Blosser and J. W. Butler (Michigan State Univ., East Lansing).

The Michigan State University cyclotron was designed for variable energy acceleration of a variety of particles. Building arrangements, beam analyzing systems, and negative ion reaction experiments are described. (M.C.G.)

38329 (CERN-63-19(p.144-8)) NEUTRON BEAM FROM THE UCLA SPIRAL-RIDGE CYCLOTRON. C. M. York, C. Ward, E. Tagliaferri, D. Hansen, J. Ewins, and A. Berick (California. Univ., Los Angeles).

Work toward the production of an intense, nearly monoenergetic beam of neutrons from the UCLA Spiral-Ridge Cyclotron is described. By bombarding the deuterium contained in heavy water with the internal proton beam of the cyclotron, a neutron beam with a relatively low energy spread was obtained. By changing the radial position of this target, the energy of the emitted neutrons could be varied. The design considerations, equipment, and measured properties of this neutron beam are described. A preliminary measurement of a total absorption cross section in carbon is presented. (M.C.G.)

38330 (CERN-63-19(p.149-51)) BEAM OPTICS STUDIES FOR THE Mc^2 CYCLOTRON. E. E. Gross (Oak Ridge National Lab., Tenn.).

From beam-extraction studies on the Mc^2 electron analog, it was estimated that the energy spread of the Mc^2 proton beam will be about 1% and that the phase-space volume will be about 80 mm mrad in both the horizontal (radial) and vertical planes. The divergence of the beam was estimated to be about ±8.8 mrad in both directions. To transport and shape the beam, simple systems of quadrupole-doublet lenses were considered. Reduction in aberrations by magnet design and by final shimming is discussed. (M.C.G.)

38331 (CERN-63-19(p.152-6)) THE EFFECT OF DUTY CYCLE ON THE RESEARCH POTENTIAL OF PION FACTORIES. K. M. Crowe (California. Univ., Berkeley); and R. P. Haddock (California. Univ., Los Angeles).

The relation of duty cycle to experiments in accelerators is discussed. It is shown that the effective duty factor is the product of the microscopic and macroscopic duty factors. The precision-measurement and discovery cases in research were considered and the effects of duty cycle calculated. It was concluded that the macrostructure should be as near 100% as possible. A flexible microstructure was indicated so that the widths of bursts and spacings between bursts could be changed. (M.C.G.)

38332 (CERN-63-19(p.157-64)) SHIELDING AND ACTIVATION OF HIGH-INTENSITY CYCLOTRONS. J. P. Blaser, Ch. Perret (Zurich. Eidgenössische Technische Hochschule); M. Barbier, and J. Dutrannois (European Organization for Nuclear Research, Geneva).

Problems of activation and shielding at the CERN synchrocyclotron are discussed. Shielding is required for biological protection, reducing background, and reducing the beam hitting vital parts that should not be activated too much. The activation level of the machine sets a practical limit to the beam intensities. The main sources of activity were found to be proton reactions with iron, copper, and aluminum. (M.C.G.)

38333 (CERN-63-19(p.165-70)) RESIDUAL RADIATION LEVELS IN THE ORNL Mc^2 CYCLOTRON. C. B. Fulmer, K. S. Toth, and J. B. Ball (Oak Ridge National Lab., Tenn.).

Residual radiation levels that will result from operation of the ORNL Mc^2 cyclotron are discussed. A general formula was derived for calculating the gamma dose rates outside slabs of materials irradiated with fast particles. A computer was used in making the calculations. Estimated ranges of radiation levels are shown in graphs. (M.C.G.)

38334 (CERN-63-19(p.171-4)) DESIGN OF TARGET SHIELDS AND BEAM CATCHERS AT CYCLOTRON ENERGIES. M. Barbier (European Organization for Nuclear Research, Geneva); and C. B. Fulmer (Oak Ridge National Lab., Tenn.).

The designs of target shields and beam stops for reducing residual radiation levels in cyclotrons by a few orders of magnitude are described. Proton beams at 600 Mev were considered. The target shield studies indicated that iron and lead are the best materials for shielding. Iron and copper were found to be the best materials for beam catchers. (M.C.G.)

38335 (CERN-63-19(p.175-82)) ORBIT STUDIES FOR A 72-INCH CYCLOTRON WITH LARGE SPIRAL ANGLE. L. W. Baumhoff, F. P. Brady, G. A. Carlson, J. A. Jungerman, and J. A. McCray (California. Univ., Davis).

Orbit studies were carried out to maximize the performance of the 72-in. magnet of the Crocker 60-in. cyclotron for use in a sector-focusing variable-energy accelerator. A computer program was written to integrate the equation of motion in the median plane for a magnetic field of threefold symmetry with sinusoidal flutter and Archimedian spiral. Beam properties during passage from the isochronous region to the electrostatic deflector were also investigated using a computer program. Results of the calculations are shown in graphs. (M.C.G.)

38336 (CERN-63-19(p.183-9)) A COMPUTER PROGRAMME FOR DETERMINATION OF CYCLOTRON FIELDS. N. Vogt-Nilsen (European Organization for Nuclear Research, Geneva).

A general program for an initial theoretical determination of relativistic AVF cyclotron fields was written in FORTRAN code for the CERN IBM 709 computer under monitor control. The computation is based on orbit coordinates (ρ,σ) in the median plane, ρ being the equivalent radius and σ the orbital arc length normalized to unity through one machine period. The curves $\sigma = 0$ and $\sigma = 1$ are the sector edges defining the machine spiral. In its most frequent application the program determines the spiral which, for a given azimuthal field variation, $B(\rho,\sigma)$ yields a specified variation of the linear vertical betatron frequency, Q_z, versus equivalent radius or energy. An illustrative example is included. (M.C.G.)

38337 (CERN-63-19(p.190-2)) SOLUTION OF POTENTIAL PROBLEMS FOR VARIABLE PERMEABILITY MATERIALS BY COMPUTER TECHNIQUE. Brank Berkes (Kernforschungszentrum, Karlsruhe, Germany and Allgemeine Elektrizitätsgesellschaft, Frankfurt am Main).

Estimation of the proper magnetic potential drop inside steel for large magnets by calculations based on Maxwell's equations is discussed. If the use of large computing machines is possible, the numerical methods show some ad-

vantages over other methods, of which accuracy and speed are the most important. The number of iterations depends on the required accuracy and the zeroth approximation of the potential distribution. A computer program for two-dimensional potential problems was written, and the flux density distribution inside the magnet pole of an isochronous cyclotron was estimated. (M.C.G.)

38338 (CERN-63-19(p.193-202)) CENTRAL-REGION STUDIES FOR THE MSU CYCLOTRON. H. G. Blosser, M. M. Gordon, and M. Reiser (Michigan State Univ., East Lansing).

Studies are being made of the central orbits in the Michigan State University cyclotron. The studies with square-wave accelerating gaps gave an initial indication of highly satisfactory performances in a double-mode acceleration system; a broad range of initial phases can be started in well-centered orbits and positioned in phase to give good axial focusing and acceleration. The Cartwheel studies, which were begun, will allow detailed design of the central geometry without recourse to approximations other than single-particle dynamics. The Cartwheel studies of the source-to-puller region indicated the importance of properly shaping the electric field in this region. The axial motion studies indicated the dominant role of the electric field in determining axial motion in the initial turns. The strong phase dependence of the electric forces offers a promising mechanism for accomplishing phase selection. The $N = 3$ axial motion results showed that it is essential to localize the electric field, by means of slits, etc., if acceleration on high harmonics is to be of significant quality. (auth)

38339 (CERN-63-19(p.203-8)) CENTRAL-REGION FACTORS INFLUENCING THE DUTY CYCLE OF A CYCLOTRON BEAM. M. Reiser (Michigan State Univ., East Lansing).

Analyses indicated that it should be possible to substantially reduce the phase-bunching effect, which is the main cause for the low duty factor of conventional cyclotrons, and produce a central beam with a pulse length approaching 160° by operating at low magnetic fields and high voltages to increase the radius of curvature, limiting the electric field to a narrow gap by attaching diaphragms to the dees in the center, and if necessary employing a d-c injection scheme. The duty factor is then limited only by the transmission capability of the magnetic field and the tolerable maximum energy spread of the extracted beam. (auth)

38340 (CERN-63-19(p.209-13)) A CENTRE-REGION MODEL OF A THREE-SECTOR CYCLOTRON. D. J. Clark (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England).

A former 4-sector center-region model cyclotron was converted to a 3-sector model to study central acceleration problems for the Variable Energy Cyclotron under construction. Preliminary operation was carried out. The rf system is a single dee and coaxial line with a movable capacitive short. Thomas ridges in the magnetic field were used instead of spiral ridges. (M.C.G.)

38341 (CERN-63-19(p.214-21)) THE CENTRAL REGION OF THE PHILIPS AVF CYCLOTRON. P. Kramer, H. L. Hagedoorn, and N. F. Verster (Philips Gloeilampenfabrieken, N. V. Forschungslaboratorium, Eindhoven, Netherlands).

A study was made of the central orbits of the Philips AVF Cyclotron to obtain information about the horizontal motion, the phase with respect to the rf field, and the vertical-focusing properties of the central region. Results of calculations are shown in graphs. (M.C.G.)

38342 (CERN-63-19(p.222-7)) THEORETICAL STUDY OF BEAM EXTRACTION BY THE METHOD OF CURVILINEAR COORDINATES. Francis Fer (Paris. Université, Orsay. Laboratoire Joliot-Curie de Physique Nucléaire).

A study was made to determine, for a given magnetic field of a cyclotron, what initial conditions of position and velocity are necessary for a particle in order that it be ejected. The problem was restricted to median plane trajectories. The method used rests basically on the choice of convenient curvilinear coordinates. (M.C.G.)

38343 (CERN-63-19(p.228-35)) THE EXTRACTION OF THE BEAM OF THE PHILIPS AVF CYCLOTRON. H. L. Hagedoorn and N. F. Verster (Philips Gloeilampenfabrieken, N. V. Forschungslaboratorium, Eindhoven, Netherlands).

The beam extraction system of the Philips AVF Cyclotron is described. Particles are accelerated as far as the field isochronism permits and extracted at a radius well beyond the resonances. The extraction system uses two separate electrostatic channels. Computer programs are available for investigating the orbital properties in the extraction region. Acceleration of the beam through the resonances and extraction of the beam are described. (M.C.G.)

38344 (CERN-63-19(p.236-42)) ORBIT CALCULATIONS ON THE EXTRACTION SYSTEM FOR THE MSU CYCLOTRON. M. M. Gordon and H. G. Blosser (Michigan State Univ., East Lansing).

Calculations relevant to the beam extraction system of the Michigan State University Cyclotron, that will be used when high external beam current with good energy resolution is desired, are presented. Static orbit properties, limitations imposed by axial stability, effects of weak field bumps on accelerated orbits, transmission of radial and axial phase-space through resonances, and effects of electrostatic deflectors are discussed. (M.C.G.)

38345 (CERN-63-19(p.243-5)) LIMITATIONS ON DUTY-FACTOR IMPROVEMENT (VIA PHASE-SHIFTING) USING H^- IONS. M. M. Gordon (Michigan State Univ., East Lansing).

The use of phase shifting to increase the duty factor and its application to H^- acceleration are described. J. R. Richardson's proposal to use of a sequence of electron-stripping wires covering a narrow r-interval in which B is made to change sharply is discussed. (M.C.G.)

38346 (CERN-63-19(p.246-250a)) PROGRESS IN THE CONSTRUCTION OF THE MILAN UNIVERSITY CYCLOTRON. M. Castiglioni, M. Fois, A. Luccio, F. Resmini, C. Succi, and G. Tagliaferri (Milan. Universita and Italy. Istituto Nazionale di Fisica Nucleare, Milan).

The magnet, its motor-generator set, and the power supply for the University of Milan Cyclotron were delivered and installed. Magnet coils were constructed. The mechanical construction of the magnet was very satisfactory. The motor-generator set met the requirement of supplying current constant to $1/10^4$ over 3-min time intervals. A full-scale model of the central region was built to study the electric field patterns by means of an electrolytic tank. The rf resonator consists of a single 180° dee attached to a stem of rectangular cross section. (M.C.G.)

38347 (CERN-63-19(p.251-5)) CORRECTING COILS OF THE ORSAY 80-INCH ISOCHRONOUS CYCLOTRONS. A. Cabrespine, M.-P. Bourgarel, and Ch. Goldstein (Paris. Université, Orsay. Laboratoire Joliot-Curie de Physique Nucleairé).

The isochronous heavy-ion cyclotron (CEVIL) at Orsay

is based on the use of materials of different magnetic permeabilities. The coils placed in the valleys are sufficient to assure isochronism for the various heavy ions accelerated in magnetic fields of between 5 and 14 kG. Metallic shimming is used for adjusting the topography of the field such that a specified ion describes a theoretical closed orbit. Since there is no correction on the hills, all the correction has to be done in the valleys. The minimum number of coils required to give a maximum field error of less than about 10^{-4} was found to be 5. (M.C.G.)

38348 (CERN-63-19(p.256-61)) RF SYSTEM OF THE ORSAY ISOCHRONOUS 80-INCH CYCLOTRON. A. Cabrespine, Y. Dupuis, and C. Bieth (Paris. Université, Orsay. Laboratoire Joliot-Curie de Physique Nucleairê).

The r-f generator is a single-tube self oscillator coupled to the resonator through an adjustable coupling loop. The frequency is regulated and adjusted by means of a servo-driven trimmer capacitor. The d-c voltage is supplied by a Graetz bridge rectifier. Classical methods of impedance transformation were used to determine the dimensions of the resonator. (M.C.G.)

38349 (CERN-63-19(p.262-9)) I. USE OF THE HODOSCOPE TO MEASURE THE AXIAL FREQUENCY OF BETATRON OSCILLATIONS. II. THE ACCELERATING SYSTEM OF THE GRENOBLE ISOCHRONOUS CYCLOTRON. H. Leboutet, J. Aucouturier, and J. C. Schnuriger (Compagnie Generale de Telegraphie sans Fil, Orsay, France).

A method for quick determination of magnetic field parameters for the Grenoble 60-Mev proton cyclotron by the "floating-wire technique" is described. Assuming identical sectors, the method consists in the determination of the transfer matrix through one sector. The trace of the matrix can be determined by measurement of the position of the trajectory in three conjugate planes. Betatron frequency was determined. The design of the accelerating system is described. (M.C.G.)

38350 (CERN-63-19(p.270-8)) MAGNET DESIGN FOR THE MSU 50-Mev CYCLOTRON. H. G. Blosser (Michigan State Univ., East Lansing).

The results of studies of the MSU magnet design established that low-spiral high-flutter magnets can be constructed within reasonable cost and power limitations. The total cost for the magnet core, coils, pole tips, and main power supply is approximately $164,000. This cost represents approximately 1/6 of the total cost of the cyclotron. The preliminary trim coil calculations indicated very moderate requirements; it is planned to provide each trim coil pair with a 30 v, 250 amp power supply yielding a connected capacity of 60 kw. Considerably less than half of this connected power will be in use at any one time so that consumed power will be in the 20 to 30 kw range. The rounded pole tip corners are believed to be a main factor in minimizing the trimming requirements. Results also established the feasibility of achieving large ν_z values near the center by the use of a magnetic cone. (auth)

38351 (CERN-63-19(p.279-85)) RADIO-FREQUENCY SYSTEM FOR THE MSU CYCLOTRON. W. P. Johnson (Michigan State Univ., East Lansing).

The radiofrequency system for the 64-in. multi-particle cyclotron at Michigan State University consists of two dees, each a quarter-wave resonant line, and a power amplifier capacitively coupled to one dee. The two 140° dees are separated by r-f ground planes so that acceleration can be achieved on even as well as odd harmonics, utilizing the characteristic push-push and push-pull modes of such a system. A full-scale model of the dee cavity and anode tank was constructed to test design concepts. The r-f amplifier is capable of delivering 240 kw of power to the dees, which should be sufficient to produce 70 kv of dee potential at 21 Mc/sec. The full-scale model is being used to develop the dee voltage regulator and to test the logic being used in the tuning servos. (M.C.G.)

38352 (CERN-63-19(p.286-90)) THE MAGNETIC FIELD OF A TWO-PARTICLE FIXED-ENERGY AVF CYCLOTRON WITHOUT TRIMMING COILS. H. L. Hagedoorn and N. F. Verster (Philips Gloeilampenfabrieken, N. V. Forschungslaboratorium, Eindhoven, Netherlands).

A study was made of a fixed-energy AVF machine that accelerates protons to an energy of about 27 Mev. The pole diameter was 1.40 m, the mean gap 24 cm, and the magnetic induction at the cyclotron center 13300 G. The magnetic field was measured for this cyclotron in a model magnet. Measurements at several excitations showed a variation of the field shape due to saturation effects in the iron. The pole segments are shimmed so that sufficient isochronism and vertical focusing is reached over the whole acceleration region. (M.C.G.)

38353 (CERN-63-19(p.291-6)) PERFORMANCE OF THE ORIC VARIABLE RF SYSTEM. S. W. Mosko, W. H. White, and R. E. Worsham (Oak Ridge National Lab., Tenn.).

Testing and installation of the master-oscillator power amplifier r-f system in ORIC are described. The r-f system is continuously tunable from 7.3 to 22.1 Mc. Resonator characteristics are the principal limiting factors in the tuning range. The π network output circuit on the driver amplifier has a continuously variable inductance consisting of a pair of transmission line stubs with a shorting plane. The r-f system was operated over most of its tuning range. Operation below 15 Mc was quite satisfactory. However, at higher frequencies, some sparking in the resonator drive line was encountered. A dee potential exceeding the 100 kv design goal was obtained throughout the 7.3 to 15 Mc tuning range. Power requirements were close to predicted levels. (M.C.G.)

38354 (CERN-63-19(p.297-300)) ORIC BEAM EXTRACTION SYSTEM. R. S. Lord, E. D. Hudson, F. M. Russell, and R. J. Jones (Oak Ridge National Lab., Tenn.).

The ORIC beam extraction system utilizes both electrostatic and magnetic channels. It was decided to extract the beam before the $\nu_r = 1$ region because of the possible beam deterioration and the difficulty of maintaining isochronism for 75-Mev protons. Two magnetic channels were developed: a coaxial channel with high-magnetic field gradient and an electromagnetic compensated iron channel with a variable magnetic field in the deflected beam region. The electrostatic channel is 77 cm long, or 56° in azimuth. A water-cooled aluminum deflector electrode and a 0.8-mm-thick graphite septum are used. (M.C.G.)

38355 (CERN-63-19(p.301-3)) DEFLECTOR POWER SUPPLY FOR SECTOR-FOCUSED CYCLOTRONS. B. H. Smith (California. Univ., Berkeley. Lawrence Radiation Lab.).

A deflector power supply that provides a simple means of adjusting the energy supplied to the sparks during the deflector bake-in period is described. The supply consists of a six-stage Cockcroft-Walton rectifier built from silicon diodes mounted on printed-circuit boards, a 100 kc oscillator to excite the rectifier, a hard-tube modulator to control the oscillator output voltage, an electronic regulator, a reference, and a precision voltage divider. It was found that, apparently, integration of the spark current starts on

the dark current preceding the actual spark, because at the more sensitive positions of the crowbar current setting, the power supply can be turned off before a spark becomes visible. (M.C.G.)

38356 (CERN-63-19(p.304-10)) ELECTRICAL DESIGN OF ELECTROSTATIC DEFLECTORS FOR SECTOR-FOCUSED CYCLOTRONS. B. H. Smith and H. A. Grunder (California. Univ., Berkeley. Lawrence Radiation Lab.).

A test-model deflector was built to obtain design data for a final deflector for the Berkeley 88-in. cyclotron. It was assumed that the deflector high-voltage electrode contains innumerable electron-emitting spots, each of which serves as the cathode for a vacuum spark. These cathodes consist of such things as foreign contaminating material, spicules, and the gradient magnifying edges of the crystals of the electrode material. A power supply was designed specifically to allow control of the bake-in process, in the hopes of improving the deflector voltage. The power supply consists basically of a six-stage Cockcroft-Walton rectifier built from silicon diodes and operating at 110 kc. Tungsten spark anodes were used. From tests it was concluded that the electric field of the deflector should be matched to the cross-section dimensions of the beam so that the high-voltage surface could be kept to a minimum. The deflector power supply should be designed to provide control of the amount of heat in the sparks. A VE number of at least $2.25 \times 10^4 (\text{kv})^2/\text{cm}$ could be held. The problem of contouring the electrodes to the trajectory of the beam was considered. (M.C.G.)

38357 (CERN-63-19(p.311-16)) CYCLOTRON BEAM POSITION SENSOR. K. Johnson and W. J. Ramler (Argonne National Lab., Ill.).

A non-intercepting beam position sensor was developed and used with the external focused beam of the Argonne cyclotron. It consists of resonantly tuned detection coils, preamplifier, and receiver. The sensor can establish the time average position of the beam but will not provide information with regard to fine structure. Each sensor coil consists of 19 turns of No. 20 solid copper conductor wound on a Type Q-1 ferrite core, 1.2-cm outer diameter and 2.7-cm long. The circuit is tuned to the cyclotron's fundamental frequency of 11.2 Mc and has an effective Q of 85. If the null detection readout is not sufficient, direction of beam displacement can be sensed by providing a means of time referencing the sensor signal to the projectile pulse. (M.C.G.)

38358 (CERN-63-19(p.317-27)) COMPARISON OF VARIOUS CIRCULAR ACCELERATORS AS MESON FACTORIES. J. R. Richardson (California. Univ., Los Angeles).

A meson factory is defined in this discussion as a proton accelerator in the energy range 400 to 800 Mev with a current output some hundred times greater than the present output of the FM cyclotrons in this energy range. The H^- sector-focusing cyclotron, the FM cyclotron with sector-focusing fields, the FFAG ring accelerator, the AG synchrotron, and the separated-orbit cyclotron were compared on duty factors, availability of the beam, variable energy, simultaneous beams, induced radioactivity in the accelerator, and development and reliability. (M.C.G.)

38359 (CERN-63-19(p.328-33)) THE PROTON LINEAR ACCELERATOR AS A PION FACTORY. G. H. Stafford (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England).

Information on the proton linear accelerator (PLA) is presented so that its value as a meson factory can be compared with the characteristics of various circular accelerators. The advantages and disadvantages of the PLA are discussed. Research on the superconducting PLA project (PLANET) is described. (M.C.G.)

38360 (CERN-63-19(p.334-9)) RECENT PROGRESS ON THE ORNL Mc^2 CYCLOTRON. R. J. Jones (Oak Ridge National Lab., Tenn.).

Development in beam extraction, ion optics, material activation, magnet, r-f cavities, vacuum system, and building layout for the ORNL Mc^2 cyclotron are described. (M.C.G.)

38361 (CERN-63-19(p.340-50)) H^- CYCLOTRON MESON FACTORY. R. P. Haddock, J. R. Richardson, and B. T. Wright (California. Univ., Los Angeles).

The design of the negative-hydrogen-ion cyclotron is described. Special requirements include: low gas pressure to reduce ion loss by stripping and a limited maximum magnetic field to reduce ion loss by electric dissociation. Radiation considerations, the magnet, the vacuum system, the accelerating system, the injector, strippers and probes, and experimental area are discussed. (M.C.G.)

38362 (CERN-63-19(p.365-71)) A VERY HIGH-INTENSITY PROTON LINEAR ACCELERATOR AS A MESON FACTORY. E. R. Beringer, W. A. Blanpied, R. L. Gluckstern, V. W. Hughes, H. B. Knowles, S. Ohnuma, and G. W. Wheeler (Yale Univ., New Haven).

The characteristics of a proton linear accelerator as a meson factory are described. It has a high-intensity primary proton beam, the external proton beam has the full intensity of the internal beam, the energy is variable in small steps, polarized protons can be accelerated, the duty cycle is reasonably high, and there is little radiation damage and activation. Types of structures, injection, control, transition, beam loading, transverse focusing and cost minimization are discussed. (M.C.G.)

38363 (CERN-63-19(p.377-85)) A STRONG-FOCUSING CYCLOTRON WITH SEPARATED ORBITS. F. M. Russell (Oak Ridge National Lab., Tenn.).

The principle underlying the concept of the strong-focusing cyclotron with separated orbits is that the equilibrium orbit is designed in three dimensions. The basic properties of this type of machine include: continuous beam output, high transverse stability, phase stability in longitudinal motion, convenient extraction of whole beam, variation of output energy in steps, no serious instability resonances, good-quality extracted beam, compact location, and no upper limit on energy. It was concluded that such a machine is well suited to serve as either a meson factory or as an injector to a second accelerator, or both if the second machine is operated in a pulsed manner. (M.C.G.)

38364 (CERN-63-19(p.386-97)) PROPOSAL FOR A 500-Mev ISOCHRONOUS CYCLOTRON WITH RING MAGNET. H. A. Willax (Zurich. Eidgenossische Technische Hochschule).

The design of a 500-Mev isochronous proton cyclotron for efficient production of high-quality beams of π and μ mesons is described. An arrangement of separated magnet sectors, leaving space for high-voltage accelerating cavities in the iron-free sections, offered an increase of the figure of merit by at least a factor of 10, compared to an isochronous cyclotron of conventional design. The physical size of the accelerating cavities also requires that this type of isochronous acceleration is limited to a radial range approximately $0.3 \leq R \leq 0.8$ (cyclotron units). Therefore, the accelerator becomes a ring into which the beam has to be injected at $\beta \gtrsim 0.3$. Beam dynamics, beam injection into the ring accelerator, beam extraction, and

accelerator layout and technical features are described. (M.C.G.)

38365 (CERN-63-19(p.398-404)) ON THE DESIGN OF THE MAGNETIC FIELD FOR A 450-Mev PROTON MACHINE. W. Mueller and W. Wolff (Allgemeine Elektrizitätsgesellschaft. Forschungsinstitut. Frankfurt am Main).

In the design of the 450-Mev proton cyclotron, it is intended to start with three sectors in the center and to change over to six sectors gradually at a suitable radial interval. The $\nu_R = 1.5$ resonance will be obtained at the edge and used for extraction by the addition of a third harmonic in the field. To get a high meson production the conditions for shifting this resonance toward higher energies were investigated. (M.C.G.)

38366 (CERN-63-19(p.405-9)) SOME RF SYSTEMS FOR CYCLOTRON MESON FACTORIES. K. R. MacKenzie (California. Univ., Los Angeles).

The r-f systems for accelerators designed to produce 100 μa at 700 Mev were studied. The dee-in-valley isochronous cyclotron, the dee-in-valley synchrocyclotron, and the negative-hydrogen-ion cyclotron were considered. (M.C.G.)

38367 (CERN-63-19(p.410-13)) MESON ACCELERATION IN CYCLIC MACHINES. R. P. Haddock (California. Univ., Los Angeles).

The feasibility of accelerating mesons(μ) in cyclic machines was investigated. Conditions for meson(μ) acceleration in different classes of accelerators were derived. Modification of an electron racetrack microtron by introducing sector-focusing, a linear accelerator for acceleration, and high-energy injection was considered, and its advantages and disadvantages are discussed. (M.C.G.)

38368 (FTD-TT-63-514) APPLICATION OF THE SIMILARITY METHOD TO INVESTIGATE THE MOVEMENTS OF POWERFUL BEAMS OF CHARGED PARTICLES IN HIGH VOLTAGE ELECTROSTATIC FIELDS. A. K. Val'ter and V. E. (Ye.) p Finkel'shteyn. Translated from Uch. Zap., Khar'kovsk. Gos. Univ., Tr. Fiz. Otd. Fiz. Mat. Fak., No. 64, 95-100(1955). 9p.

Experiments on similar low voltage models can be used to determine experimentally the form of a charged particle beam in a strong electrostatic field, as well as the dimensions of the spot produced when the beam hits a target. Criteria for the realization of beam similarity in such experiments are derived. The focusing properties of accelerating systems were investigated using the similarity criteria with model experiments. Ionization of gas in the tube by secondary phenomena was found not to distort the experimental results. (D.C.W.)

38369 EFFICIENCY OF THE OPERATION OF BETATRONS. George Baciu. Acad. Rep. Populare Romîne, Studii Cercetări Fiz., 14: 159-76(1963). (In Rumanian)

No theory previously developed was able to explain the role of factors responsible for the efficient operation of betatrons. Attempts were made to explain the capture of electrons by a given distribution of azimuthal phase inhomogeneities of the magnetic field, by the existence of resonances between the free betatron oscillations and the rotational frequency of the orbiting electrons or by the presence of space charges in the accelerating chamber. The problem was reduced to a study of the space charges formed during the injection of electrons into the betatron; accumulation of these charges, formed by the injection of electrons with different initial energies may affect the amount of the electrons captured and may interfere with their acceleration. The problem was considered on the basis of experimental data reported in "Elektronnye Tsirkularnye Uskoriteli" (Izv. Tom. Pol. Inst., 87 (1957)). It was concluded that electrons may be injected into the accelerating chamber, to be deliberately captured during the betatron process only within a specific time period. The duration of the injection pulse is equal to the capture period. For a given value of the injection tension, there is an optimum value for the emission current and a most suitable moment for the injection. For a beam injected into an inhomogeneous field, there is required minimum injection tension. (TTT)

38370 SOME UNIQUE-MECHANICAL CONSTRUCTIONS APPLIED TO THE CYCLOTRON OF THE "INSTITUUT VOOR KERNPHYSISCH ONDERZOEK" AT AMSTERDAM. H. J. M. Akkerman. Fijntechniek, 2: No. 8, 154-64(1962). [(In Dutch)]

A short description was given of the aim and the operation of the cyclotron. Some constructions destined for the vacuum system are enumerated. Mentioned are flange sleeves, jointing of valves, couplings of vacuum pipes, dynamical joints, pneumatic operation, vacuum valves, and an automatically steered catch plate holder. (RCN)

38371 MAGNETIC QUADRUPOLE LENS FOR LINEAR ACCELERATORS WITH TRANSIT TUBE. I. REQUIREMENTS OF LENS AND CHOICE OF FORM FOR THE POLE SHOE. I. M. Kapchinskii and V. K. Plotnikov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 3, 15-19(May-June 1963). (In Russian)

The permissible dimensions of a nonlinear magnetic field in a quadrupole lens for a linear accelerator with a transit tube are discussed. Restrictions are imposed on the form of the pole shoe by the size relation of the tube external diameter to aperture diameter. Results indicate that the best image is obtained with plane pole shoes with dimensions such that the coefficient for the fifth harmonic of the magnetic field is practically nil. (tr-auth)

38372 MAGNETIC QUADRUPOLE LENS FOR LINEAR ACCELERATORS WITH TRANSIT TUBE. II. MEASUREMENT OF NONLINEAR FIELD FOR LENS WITH PLANE POLE SHOES. E. N. Daniltsev and V. K. Plotnikov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 3, 20-4(May-June 1963). (In Russian)

A method for measuring the nonlinear field of a magnetic quadrupole lens with the aid of harmonic coils is presented. Results of field measurements for a lens with plane pole shoes with a suppressed fifth harmonic are given. Comparison is made between pole shoes of this form and those adapted for other linear accelerators. A method of compensation for distorted fields arising from the effect of coil windings and variation of the pole shoe design is also discussed. (tr-auth)

38373 LINEAR ACCELERATOR FOR 5-Mev ELECTRONS (MODEL Y-12). O. A. Valdner, A. A. Glazkov, and A. I. Finogenov (Moscow Inst. of Engineering Physics). Pribory i Tekhn. Eksperim., No. 3, 29-32(May-June 1963). (In Russian)

The characteristics of the Y-12 linear accelerator are presented. Electron energies range from 4 to 5 Mev with a current between 40 and 70 μa and gamma dose up to 600 r/min. (tr-auth)

38374 RETRACTABLE LOW TEMPERATURE TARGETS FOR HIGH ENERGY PHYSICS EXPERIMENTS. B. Chambers, R. Hofstadter, A. Marcum, and M. Yearian

(Stanford Univ., Calif.). Rev. Sci. Instr., 34: 1019-22 (Sept. 1963).

A system is described which allows as many as five different low-temperature targets to be positioned vertically inside a vacuum system. The targets normally contain liquid hydrogen or deuterium. The vertical travel is obtained by using a bellows system in such a way that the overall external height of the system is constant. A maximum travel of 4 in. can be obtained. (auth)

38375 THE 24-Mev BETATRON. B. Pierquin (Institut Gustave Roussy, Villejuif, France). Techn. Hosp., 18: Suppl., 52-4(Jan. 1962). (In French)

Installation and characteristics of the 24-Mev betatron apparatus at the Institute are described. (BBB)

Plasma Physics and Thermonuclear Processes

38376 (LRP-1-63) SYSTEMES OSCILLANTS PEU AMORTIS, COMMUTES AVEC UN ECLATEUR DE FAIBLES PERTES. (Weakly Damped Oscillating Systems, Connected with a Spark Gap for Small Losses). R. Keller (Laboratorie de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Apr. 1963. 10p.

The energy of an oscillating circuit decreases rapidly when a spark gap is connected in series because the energy is mostly dissipated by the arc. It is possible to substitute the energy dissipated in a spark gap by an exterior source of energy, constituted by another oscillating system of lower frequency. The decrement due to the arc can be reduced in some cases to a value which is inferior to the proper losses of the oscillating circuit. When the auxiliary energy is supplied by a cable connected in parallel with the spark gap the switching time is also shortened. It is then possible to produce weakly damped oscillations up to 30 Mc. (auth)

38377 (LRP-5-63) BANC DE CONDENSATEURS POUR THETA PINCH. (Bank of Condensers for Theta Pinch). J. P. Perotti (Laboratorie de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Apr. 1963. 12p.

Capacitor bank circuitry capable of producing nearly rectangular current pulses of 2-μsec rise time, 15-μsec duration, and 800-kamp is described. (auth)

38378 (AEC-tr-5985) THE DIFFUSION PHENOMENA OF THE POSITIVE COLUMN IN A MAGNETIC FIELD. M. Sato and Y. Hatta. Translated for Oak Ridge National Lab., Tenn. from Kakuyugo-Kenkyu. 10: 373-86(1963). 16p.

Ambipolarity of the plasma diffusion across a magnetic field is experimentally checked by measurements of the longitudinal electric field in a short positive column. The results of the field measurement show that there is no diffusion due to the short circuit effect and that the diffusion is ambipolar independent of the tube dimension. (auth)

38379 (NP-tr-1057) ION CYCLOTRON APPARATUS. Interim Report. Translated by L. Allen (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Kakuyûgô-Kenkyû, 9: 351-75(1962). 71p.

A magnetic mirror device constructed to investigate the trapping of injected ion beams by ion cyclotron heating is described, and initial experiments on it are reported. An ion beam was successfully trapped in the device, but an inadequate vacuum led to an r-f discharge that limited heating. Insufficient vacuum also resulted in the loss of trapped ions by charge exchange collisions with residual neutral molecules. A high-density plasma source is a notable feature of the device. (D.C.W.)

38380 INSTABILITY OF PLASMA SHEATH ROTATION AND ASSOCIATED MICROWAVE GENERATION IN A PENNING DISCHARGE. W. Knauer, A. Fafarman, and R. L. Poeschel (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Letters, 3: 111-12(Oct. 1, 1963).

The instability of the rotating current that generates intense microwave noise radiation in a split anode configuration was investigated. Several bands of incoherent radiation were found in the spectrum. It was concluded that the rotating sheath was bunched and that it induced currents in the anode halves to produce the observed radiation. The only instability that could explain the radiation pattern satisfactorily was the diocotron effect or slipping stream instability that was previously observed in cross field microwave tubes. (C.E.S.)

38381 PLASMA REFRACTIVE INDEX BY A LASER PHASE MEASUREMENT. J. B. Gerardo and J. T. Verdeyen (Univ. of Illinois, Urbana). Appl. Phys. Letters, 3: 121-3(Oct. 1, 1963).

A laser interferometer was used to determine the refractive index of plasma. The output from the laser was sent through the plasma and reflected back onto itself by a spherical mirror. The amplitude of the laser output depends upon the phase of the signal fed back into the laser cavity from the mirror system which forms a high-Q cavity whose resonant frequencies depend upon the refractive index of the plasma. If the plasma density changes with time, a sequence of resonances at the laser frequency is excited in the cavity. (C.E.S.)

38382 INTERACTION OF A BUNCHED ELECTRON BEAM WITH A GYROTROPIC PLASMA. Basil W. Hakki (National Science Council, Damascus, Syrian Arab Republic). J. Appl. Phys., 34: 531-7(Mar. 1963).

The interaction of a prebunched beam with an anisotropic medium is considered for the generation of coherent electromagnetic energy in the low and submillimeter region. Generalized expressions are obtained for the fields created by a prebunched beam of general shape in an anisotropic medium. The permeability is assumed to be a scalar constant whereas the permittivity is tensorial. Two special cases are considered: one is that of a helical prebunched beam and the other is that of a rectilinear beam, both interacting with gyrotropic gaseous plasmas. Ionization, scattering, and r-f field effects on the beam are neglected. In addition to the solutions of the inhomogeneous vector wave equation, a method is suggested whereby the free mode solutions could be directly deduced. (auth)

38383 QUASI-ONE-FLUID THEORY OF WAVE PROPAGATION IN A FULLY IONIZED PLASMA. Joseph E. Willett (General Dynamics Corp., Fort Worth, Tex.). J. Appl. Phys., 34: 574-9(Mar. 1963).

A complete set of linearized two-fluid equations for the perturbation of a viscous, heat conducting, fully ionized plasma is transformed into an equivalent set of equations in the one-fluid quantities. The quasi-one-fluid formulation thereby obtained is applicable to a wider class of phenomena than the magnetohydrodynamic formulation and differs from the latter because of terms corresponding to current inertia, Hall effect, space charge, diffusion, unequal electron and ion temperatures, viscous electric effects, and a viscous force arising from nonuniform currents. Dispersion relations are obtained for waves of small amplitude.

Included are equations showing the effects of viscosity on electron electrostatic, ion electrostatic, and electromagnetic waves in the absence of a static magnetic field, and Alfvén waves propagating along a magnetic field. (auth)

38384 A PARTICULAR SOLUTION OF THE LINEARIZED BOLTZMANN EQUATION. Gordon Kent (Syracuse Univ., N. Y.). J. Appl. Phys., 34: 1426-9(May 1963).

A particular solution of the linearized Boltzman equation, applicable to longitudinal oscillations of a one-dimensional plasma without collisions, is constructed. It has the properties that (i) the Vlasov dispersion relation is satisfied rigorously; (ii) that for large values of time, the perturbation decays as $1/t^{\frac{3}{2}}$; and (iii) that the solution may be singular at some points. The solution is not included in the theories of Van Kampen or Landau because of (iii), but it is in no sense a general solution of the initial value problem. The frequency at which damping is slowest is approximately twenty-five percent above the plasma frequency. (auth)

38385 RESONANCE PHENOMENA IN A GASEOUS DISCHARGE IN A STRONG MAGNETIC FIELD. Basil Beeken, Robert Goldman, and Ludwig Oster (Yale Univ., New Haven). J. Appl. Phys., 34: 1430-9(May 1963).

The r-f spectrum of a gaseous discharge in a strong magnetic field is measured with the aid of a fixed frequency receiver by sweeping the magnetic field by approximately two percent. Source of radiation and receiving equipment are described. The following results were obtained: a series of emission lines around the cyclotron frequency, an emission at a frequency which increases with increasing magnetic field strength and decreases with increasing external voltage, and a strong resonance when both frequencies coincide. The intensity increases by a factor of 100 and more. The frequency spectrum is discussed in terms of a simple theory, which accounts for local space-charge fields. Their spatial distribution is inferred from the frequency behavior of the emission lines. Finally, a mechanism is suggested that classifies the resonance effect as an energy transfer from a longitudinal plasma mode into electromagnetic radiation. (auth)

38386 INTERACTION BETWEEN A DIELECTRIC (OR COLD PLASMA) AND A CAVITY. K. I. Thomassen (Stanford Univ., Calif.). J. Appl. Phys., 34: 1622-9(June 1963).

The interaction between a cylindrical plasma column (or dielectric material) and a resonant cavity from which it protrudes is investigated. From the results, one may determine the dielectric constant and loss, or in the case of a plasma, the plasma frequency and collision frequency, given measured values of the resonant frequency shift and change in the cavity Q. The theory differs from earlier theory on cylindrical cavities in that it treats a cavity of more general shape, although restricted to TM modes, and takes into account the subtle boundary effects at the openings through which the plasma is admitted. These effects may be calculated by estimating the field variation over the part of the cylindrical plasma surface that lies inside the cavity. (auth)

38387 INTERDEPENDENCE OF PLASMA FREQUENCY AND SURFACE DIFFUSIVITY FROM ELECTROMAGNETIC SCATTERING ANALYSES. Philip J. Wyatt (Plasmadyne Corp., Santa Ana, Calif.). J. Appl. Phys., 34: 2078-83 (July 1963).

A thorough examination of the far field electromagnetic scattering characteristics of a spherically symmetric plasma indicates quite clearly the possibility of obtaining ambiguous results from microwave measurements. This ambiguity arises because of an interdependence of the average plasma frequency and the surface diffusivity. In order to differentiate between these two physical causes, an analysis of the differential scattered intensity is undertaken. This latter quantity is found to be extremely sensitive to variations in plasma frequency and surface diffusivity and may be used to separate the effects of each. (auth)

38388 RESONANCE OF SURFACE WAVES ON A CYLINDRICAL PLASMA COLUMN. Vasuo Akao and Yoshio Ida (Nagoya Univ., Japan). J. Appl. Phys., 34: 2119-20(July 1963).

The multiple peaks found in the absorption spectrum of microwave radiation scattered by a cylindrical plasma column are investigated. Experimental results carried out at 1.5 Bc in which the main peak and the minor peaks on the low-frequency side are seriously affected by varying the effective length of plasma and the theoretical interpretations of this phenomena are presented. It is concluded that the main peak and the peaks on the low-frequency side are caused by the multiple resonance of the surface waves that propagate axially in both directions being reflected from the ends of the plasma. (C.E.S.)

38389 A MICROWAVE METHOD FOR THE STUDY OF STEADY AND FLUCTUATING PLASMA NUMBER DENSITIES. F. W. Crawford, G. S. Kino, S. A. Self, and J. Spalter (Stanford Univ., Calif.). J. Appl. Phys., 34: 2186-96 (Aug. 1963).

A method for the measurement of d-c and a-c components of number density in cylindrical gas-discharge columns was studied. The technique is based on a dipole resonance, occurring below the electron plasma frequency. It is excited by an r-f signal transmitted along a stripline enclosing the plasma column. By working on the side of the resonance curve, a fluctuating output signal is obtained corresponding to the density fluctuations. The simple theory of the resonance was extended to take account of stripline size, of the glass surrounding the column, and of a radial variation in number density. The method is considerably more sensitive than cavity perturbation techniques, and the results compare reasonably well with number density measurements made by other methods. (auth)

38390 BEAM-GENERATED BEAM-PLASMA SYSTEM. James E. Hopson (Sperry Gyroscope Co., Great Neck, N. Y.). J. Appl. Phys., 34: 2425-9(Aug. 1963).

The generation of a plasma as a result of passing a magnetically focused cylindrical electron beam through a neutral gas is treated. It is theoretically shown on the basis of a particle diffusion model and was experimentally verified that a certain minimum critical pressure is required for the beam to generate a plasma. For gas pressures in excess of this critical pressure, the equilibrium plasma density is greater than would be expected only from ionizing collisions between primary beam electrons and neutral gas molecules. This increased plasma density is associated with the generation of microwave noise. (auth)

38391 PLASMA FLOW AROUND A THREE-DIMENSIONAL DIPOLE. W. H. Bostick, H. Byfield, and M. Brettschneider (Stevens Inst. of Tech., Hoboken, N. J.). J. Geophys. Res., 68: 5315-17(Sept. 15, 1963).

Photographs of plasma flow around a three-dimensional dipole (hollow loop coil) in a vacuum chamber indicate the analog of a Van Allen belt, especially on the windward side. (D.C.W.)

38392 A THEORY OF INCOHERENT SCATTERING OF RADIO WAVES BY A PLASMA. 3. SCATTERING IN A PARTLY IONIZED GAS. J. P. Dougherty (Cambridge

Univ., Eng.) and D. T. Farley, Jr. J. Geophys. Res., 68: 5473-86(Oct. 1, 1963).

The theory of incoherent scattering in a plasma is extended to include the effect of ions and electrons colliding with neutral molecules, an effect that could be important in the ionosphere below perhaps 150 km for experiments at frequencies of the order of 50 Mc or less. It is found that the total scattered power is completely independent of collisions; the collisions only affect the shape of the spectrum. If, as is usually the case, the Debye length [6.9 $(T/N)^{1/2}$ cm] is small compared to $\lambda/4\pi$ (λ is the radio wavelength), the spectrum begins to become narrower and peaked at the center when the mean free path of the ions becomes comparable to $\lambda/4\pi$. Any possible ion gyroresonant effects on the spectrum due to the presence of a magnetic field will be prevented if the collision frequency of the ions is greater than or equal to their gyrofrequency. If the Debye length should happen to be greater than $\lambda/4\pi$, the above comments would apply to the mean free path, collision frequency, and gyrofrequency of the electrons; however, such electron effects are not likely to be important in the ionosphere. It does seem that perhaps the ion collision rates might be measured by means of incoherent scattering. The principal difficulty would be in obtaining, from low altitudes, incoherent scattering signals uncontaminated by other types of scattering. (auth)

38393 STIMULATED-EMISSION EFFECTS IN HOT PLASMAS. D. E. McCumber and P. M. Platzman (Bell Telephone Labs., Murray Hill, N. J.). Phys. Fluids, 6: 1446-52(Oct. 1963).

Conditions are considered for which stimulated emission modifies the sharp-line electromagnetic radiation emitted from partially ionized heavy impurities in a hot plasma. Analysis of a simple model permits a semiquantitative estimate of the radiation enhancement and of the spectral modifications that accompany superradiance in actual systems. (auth)

38394 INCOHERENT SCATTER FROM A HOT PLASMA. Richard A. Pappert (General Dynamics/Astronautics, San Diego, Calif.). Phys. Fluids, 6: 1452-7 (Oct. 1963).

Within the limits of the first Born approximation, the incoherent scatter from a hot plasma is determined in terms of the spectral density of the induced current fluctuations. A significant parameter β_e for assessing the importance of relativistic effects is the square root of the ratio of the electron temperature to the rest mass energy of the electron. First-order corrections in this parameter to the incoherent spectrum are calculated for a plasma in the absence of an external magnetic field. To first order in β_e the total cross section remains unaltered. However, an asymmetry in the cross section per unit frequency about the incident frequency, Ω_0, does occur. The magnitude and shape of this correction are determined. (auth)

38395 EXCITATION OF WAVES IN A WARM PLASMA BY A CURRENT SOURCE. Hans H. Kuehl (Univ. of Southern California, Los Angeles). Phys. Fluids, 6: 1465-9 (Oct. 1963).

The general expression for the electromagnetic field due to an arbitrary monochromatic current source is an unbounded, homogeneous, warm, collisionless plasma in the absence of a magnetostatic field is derived. A hydrodynamic description is used in which ion and electron motion is included. The general results are specialized to the case of an electric dipole source. It is found that the field is generally composed of three parts which, in the radiation region, correspond to the well known transverse, longitudinal electron, and longitudinal ion waves. The power flow in the radiation region is shown to be largest along the axis of the dipole for low frequencies whereas the maximum occurs perpendicular to the dipole at high frequencies. (auth)

38396 PLASMA DIFFUSION IN A MAGNETIC FIELD. D. R. Whitehouse and H. B. Wollman (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 6: 1470-8(Oct. 1963).

The two-dimensional diffusion of a partially ionized plasma in a magnetic field is studied using the macroscopic plasma equations. For a stable steady-state plasma with uniform electron temperature and ionization frequency, it is shown that the density distribution can exist only in the lowest mode by virtue of the internal constraint that the space charge potential is conservative. While the electron and ion diffusion currents in an insulating cavity are everywhere equal, similar to Schottky's ambipolar diffusion theory for one dimension, the plasma in a conducting cavity exhibits an increase in the net particle current to the walls and an unbalance of ion and electron currents in the plasma. Thus an amperian current flows through the plasma and returns through the walls. With adjustable d-c potentials applied to the walls of a split cavity, these currents may be continuously varied and even decreased below those given by the ambipolar condition. An experiment with a microwave cavity discharge demonstrates the existence of these unbalanced currents. (auth)

38397 EQUILIBRIUM OF A TOROIDAL PLASMA WITH A CONDUCTING APERTURE LIMITER. Shoichi Yoshikawa, Wynford L. Harries, and Rolf M. Sinclair (Princeton Univ., N. J.). Phys. Fluids, 6: 1506-15(Oct. 1963). (MATT-178)

A conducting limiter brings about equilibrium of a toroidal plasma by anchoring magnetic field lines. Charge separation arising from the curvature effect can be short circuited by the limiter. This way of achieving equilibrium is not possible if the charge separation current exceeds the maximum ion saturation current to the limiter. Experiments with the Model C stellarator are consistent with this model. An observed instability is related to the loss of equilibrium due to the excess charge separation current. (auth)

38398 IMPURITY CONTENT OF PLASMA PRODUCED BY A COAXIAL PLASMA GUN. Harold P. Eubank (Princeton Univ., N. J.). Phys. Fluids, 6: 1522-4(Oct. 1963).

The impurity content of plasmas produced by a coaxial plasma gun, while low, has generally been estimated by measurements of qualitative nature. Since impurities constitute the primary source of radiation loss and cooling, a study was made to explore this plasma property. (R.E.U.)

38399 PLASMA INJECTION INTO A MULTIPOLE FIELD. T. Ohkawa, A. A. Schupp, Jr., H. G. Voorhies, and W. C. Duesterhoeft, Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 6: 1526-8(Oct. 1963).

The injection of plasma across and into a magnetic field generated by a multipole device is investigated. The multipole field was generated by four rods carrying current in one direction with the return current in the wall of the device. The field at the entrance port for the plasma was 2400 gauss, and the maximum field around the rods was 9000 gauss. A coaxial plasma gun was used to produce a 2 kw hydrogen plasma. (R.E.U.)

38400 COMMENTS ON "EXTRACT RELATIVISTIC FOKKER-PLANCK COEFFICIENTS FOR A PLASMA."

Ronald Fante (Princeton Univ., N. J.). Phys. Fluids, 6: 1528(Oct. 1963).

An inconsistency in the derivation of the kinetic equations for particles and radiation given by Simon (NSA 15: 16554) is pointed out, and another method of solution is discussed. Actual calculations are not presented. (R.E.U.)

38401 BROWNIAN MOTION IN A MAGNETIC FIELD. Behram Kursunoğlu (Univ. of Miami, Coral Gables). Phys. Rev., 132: 21-6(Oct. 1, 1963).

Diffusion of electrons and ions in a plasma across a magnetic field with the interplay of an anisotropic dynamical friction is formulated in terms of the methods of Brownian motion. For a special symmetry of the dynamical friction matrix it is found that for Larmor periods of the order of the relaxation time across the magnetic field the diffusion takes place as an ordinary Brownian motion uninhibited by the external magnetic field. (auth)

38402 SPOT CONDUCTION OF CURRENTS BETWEEN MOVING PLASMA AND COLD ELECTRODES. P. R. Smy (Univ. of British Columbia, Vancouver, Can.). Proc. Phys. Soc. (London), 82: 231-42(Aug. 1, 1963).

The electrical impedances of several pairs of cold metal electrodes immersed in moving shock-heated argon are measured by applying constant, increasing, and decreasing voltages to the electrodes. Two distinct conduction regimes are found to exist — one where the electrode impedance is very high and is approximately inversely proportional to electrode surface area, and one where the electrode impedance is virtually independent of electrode area for electrode current densities less than 10^6 amp/cm^2. It is deduced that the first regime arises when few electrons are emitted from the cathode, whereas the second regime exists when many electrons are emitted from a small fraction of the cathode area. A simple theory of a cathode spot is proposed, which shows at least order-of-magnitude agreement with the experimental observations and explains various unusual characteristics of the impedance. (auth)

38403 MEASUREMENTS OF RESONANCE RECTIFICATION USING A PLASMA PROBE. R. B. Cairns (Dept. of Scientific and Industrial Research, Slough, Bucks, Eng.). Proc. Phys. Soc. (London), 82: 243-51(Aug. 1, 1963).

If an alternating potential is applied to a probe inserted in a plasma the probe collects a steady rectified current. This current is greatest when the frequency of the applied potential is equal to the plasma electron frequency. This phenomenon may be called resonance rectification. A theoretical explanation of the phenomenon exists. Experiments made to test the theory are described. The experimental results are, to first order, in agreement with the theory. (auth)

38404 ADIABATIC CHARGED-PARTICLE MOTION. Theodore G. Northrop (Univ. of California, Berkeley). Rev. Geophys., 1: 283-304(Aug. 1963). (UCRL-10750)

The adiabatic theory of charged-particle motion is developed systematically. The general expressions for guiding-center motion and particle energy change are given, with application to the Van Allen radiation and to Fermi acceleration. It is shown that Fermi acceleration and betatron acceleration should not be regarded as distinct processes. Modifications of the nonrelativistic theory that are necessary when the particle is relativistic are discussed. Proofs are given of the invariance to lowest order of the first and second adiabatic invariants for the case of static fields. Finally, applications are made to the theory of plasmas. (auth)

38405 RADIO-FREQUENCY EXCITED PLASMA TUNNEL FOR LABORATORY STUDIES OF SUPERSONIC PLASMA FLOW FIELDS. Allan I. Carswell (RCA Victor Co., Ltd., Montreal). Rev. Sci. Instr., 34: 1015-19(Sept. 1963).

A description is given of a supersonic, low-density plasma tunnel employing r-f excitation of the gas stream. The facility, which was designed to be of laboratory proportions, provides clean, supersonic plasma streams at velocities up to about Mach 2. The static stream pressures available are in the range from about 0.1 to 10 Torr and jets up to 2 or 3 cm in diameter are produced. A discussion of the important design features is given and the application of this facility to several studies of supersonic plasma flow fields is described. (auth)

38406 THE INVESTIGATION OF A NITROGEN PLASMA OF HIGH PARTICLE DENSITY WITH MAGNETIC PROBES. W. Thielo (Technische Hochschule, Stuttgart). Z. Naturforsch., 18a: 854-68(July 1963). (In German)

A high current pulse discharge in N with gas-eddy-stabilized predischarge was studied with a magnetic probe. The operational conditions necessary for this study and the construction of the probes used were fully described. The measurement results gave a survey on the spatial and time behavior of the current, the Ohm field strength, electric conductivity, and temperature in the plasma during discharge. Geometry and stability of the plasma and a critical review of the method with optical and electrical auxiliaries make the values appear correct. A good agreement with the results of other methods and the theoretical treatment of the problem studied is to be established. (tr-auth)

38407 THE STRUCTURE OF THE PLASMA CLOUD IN THE ELECTROMAGNETIC COLLISION WAVE TUBE. G. Brederlow (Institut fur Plasmaphysik, Garching, Ger.). Z. Naturforsch., 18a: 868-76(July 1963). (In German)

The structure of the plasma cloud propagated in an electromagnetic collision tube was studied. By comparison of the luminous front velocity with the velocity of the plasma streaming following this front in hydrogen at pressures from 0.1 to 2.5 Torr, the presence of a plasma heated by a collision wave was tested. The streaming velocity of the plasma was determined by a measurement method given by Sakuntala, Engel, and Fowler, and the propagation velocity of the luminescence was investigated with a Schmier camera. The experiments showed that a collision wave appeared before the discharge plasma thrown out by the electromagnetic force. The collision wave plasma forms, however, continually the by far smaller part of the plasma cloud. It was further shown that the streaming velocity was not constant across the tube diameter. It decreased with increasing distance from the tube axis. Since the pattern of the light intensity on the probe was measured simultaneously with the streaming velocity, the distance of the front defined by the increase of the streaming velocity from the luminous front could be determined. The compression behavior of the collision wave plasma at different Mach numbers was measured and compared with the values calculated by Turner, taking into consideration the dissociation and ionization. There was good qualitative agreement between calculated and measured results. (tr-auth)

38408 PROOF OF EXCLUSION IN MAGNITUDE FOR THE INCOMPRESSIBLE MAGNETOHYDRODYNAMIC EQUATIONS. E. Martensen (Max-Planck-Institut für Physik und Astrophysik, Münich). Z. Naturforsch., 18a: 878(July 1963). (In German)

38409 REFLECTION EXPERIMENTS WITH ELECTROMAGNETICALLY PRODUCED SHOCK WAVES. Wilhelm Fucks and Rolf Theenhaus (Technische Hochschule, Aachen). Z. Physik, 175: 257-63(1963). (In German)

Plasma was accelerated by the discharge of a fast condenser bank through a conical, single-turn brass coil. The moving plasma was accompanied by a luminous phenomenon, which was examined by the aid of a smear camera and an image-converter camera before and after being reflected at a plane piston. Helium was used from 0.1 to 10 Torr. The propagation can be described by a power law. By means of these reflection experiments a non-luminous front preceding the luminous phenomenon in a tube of 18 cm length could not be observed. (auth)

38410 RADIATION EMITTED BY FAST PARTICLES IN AN UNSTATIONARY INHOMOGENEOUS MEDIUM. K. A. Barsukov and B. M. Bolotovskii (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 303-4(Aug. 1963). (In Russian)

The spectrum and intensity of radiation emitted by fast charged particles in a periodically unstationary and inhomogeneous medium are considered. (auth)

38411 IONIZATION LOSSES IN AN INHOMOGENEOUS MEDIUM. N. P. Kalashnikov and M. I. Ryazanov (Moscow Inst. of Engineering Physics). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 325-32(Aug. 1963). (In Russian)

A general expression is obtained for the ionization losses of a fast particle in a medium with statistical inhomogeneities. The results are applied to the case of discrete energy losses, longitudinal losses in a plasma, and radiation emission on density fluctuations. (auth)

38412 INTERACTION IN BEAM-PLASMA SYSTEMS. Bjoern Nils Anders Lamborn. Thesis, Gainesville, Fla., Univ. of Florida, 1962. 99p.

The dispersion relation for the electrostatic interactions of a beam-plasma system was developed using collective coordinates. The system was divided into an arbitrary number of streams, each of which contains particles with a unique charge, mass, and mean velocity, excluding thermal variations. The equations of motion for the collective coordinates representing the streams were developed in the limit where short-range collisions may be neglected. The corresponding dispersion relations were derived for a system with an arbitrary number of components and discussed for several cases. The unstable regions derived for a two-beam instability were in qualitative agreement with those previously found from the Boltzmann equation by a Fourier-Laplace-transform method. For the interaction between two modulated beams and a background gas, as may occur when beams are transmitted through a plasma region, it was found that, besides exciting the linear two-beam instability, there exists the possibility of exciting other modes of plasma by the beams. The interaction between an ion beam and a neutralizing electron background gas in a magnetic field is discussed. In general the electrons move in small Larmor orbits in the beam region, but if the field is inhomogeneous they may have a net coherent superimposed drift motion, which may interact collectively with the ion beam motion. For the case of an ion ring current moving azimuthally about the field origin of a radially varying magnetic field, this drift motion is also azimuthal. The resulting instability tends to accelerate the electrons until their velocity is the same as the ion beam velocity, with a growth rate proportional to the plasma frequency, in the limit where this frequency is greater than the frequency of short-range collisions. (Dissertation Abstr.)

38413 ION CONFINEMENT IN A GAS DISCHARGE CONTROLLED BY SECONDARY ELECTRON RESONANCE. Eugène John Clothiaux. Thesis, University Park, N. Mex., New Mexico State Univ., 1963. 68p.

In high frequency gaseous breakdown controlled by secondary electron emission, the oscillating motion of the electron cloud creates an effective static potential well for ions. The existence of this well was demonstrated experimentally by firing an ion beam through the discharge and measuring the beam deflection. This experiment proved that at low pressures few ions are present in the discharge, but with increasing pressure the ions increase in number and are confined by the electron potential. It also showed that for sufficiently large ion densities, the associated ion potential becomes larger than the electron potential, and electrons can be trapped by the sum potential. These findings are in agreement with the solution of the transport equations in the high-pressure regime, $10^{-4} \leq P \leq 10^{-2}$ Torr, for the ion number density distribution and the associated ion potential. A model for the formation of r-f plasmoids is proposed based on the motion of the electrons trapped in the sum potential well, and it is shown how some of the observed features of plasmoids are a consequence of the proposed model. Alternatively, a plasmoid may be a standing wave phenomenon. Hydromagnetic and electromagnetic waves are not possible, but electrostatic waves are not excluded. The results of an experimental attempt to detect such waves were inconclusive. (Dissertation Abstr.)

38414 ELECTRICAL AND OPTICAL STUDIES OF THE ARGON PLASMA JET. M. D. Watson, H. I. S. Ferguson, and R. W. Nicholls (Univ. of Western Ontario, London). Can. J. Phys., 41: 1405-19(Sept. 1963).

A preliminary study is made of the physical processes occurring in an argon plasma jet flowing at Mach 2.5. Axial electron and ion temperatures and densities are measured as functions of distance along the jet, using spectroscopic and electrical probe techniques. Estimates are also made of the degree of ionization, the electron-ion recombination coefficient, and the ambipolar diffusion coefficient. It is found that electron temperatures (~4000°K) are about twice as large as the effective rotational temperatures of N_2 molecules (~1500°K) and thus of ion temperatures. Electron densities are $\sim 10^{12}$ cm^{-3}. The degree of ionization is $\sim 6 \times 10^{-4}$. The dominant mechanism for deionization is found to be dissociative recombination (between electrons and A_2^+ ions) over the first 8 cm of the jet, after which ambipolar diffusion seems to become important. (auth)

Shielding

38415 (EIR-53) A BUILD-UP CORRECTED SINGLE COLLISION MODEL FOR GAMMA RAY BACKSCATTERING. Walter Lowen (Switzerland. Eidgenossisches Institut fur Reaktorforschung, Wurenlingen). June 1963. 70p.

A build-up corrected single collision Kernel was developed to calculate the backscattered energy flux at a specified location resulting from a monoenergetic point monodirectional gamma beam with a given angle of incidence on a scatterer of specified thickness. The formulation is supported by phenomenological analysis and by a comparison of total energy albedos, as calculated by

a single collision Kernel, to Monte Carlo data. The angular distribution of reflected energy was computed by means of a build-up corrected single-collision Kernel for 1-Mev gamma rays backscattered from concrete. The results are shown to be in good agreement with Monte Carlo data. (P.C.H.)

38416 (HW-78274) RADIATION SHIELDING PROGRAM AT HANFORD. W. L. Bunch (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 15, 1963. Contract AT(45-1)-1350. 28p.

The radiation sources and interaction processes involved in the shielding problem are described briefly. The facilities used in the Hanford experimental shielding program are described, and some neutron measurements in concrete are given. A Multigroup Attenuation Code (MAC) was developed for shielding calculations, and comparison is made between calculated and experimental neutron fluxes and gamma doses in ferrophosphorus concrete and in alternate iron-masonite layers. Calculated neutron spectra are given for various places within the shield configuration. The MAC code was used to study the merits of various shield configurations, and results are given. Future research planned in the Hanford shielding program is outlined. (D.L.C.)

38417 (JAERI-6012) GRAPHS OF EXPONENTIAL INTEGRAL FUNCTION $E_1(x)$ AND $E_2(x)$. Akira Tsuruo and Tayoru Toyoda (Japan Atomic Energy Research Inst., Tokyo). Nov. 1962. 25p. (In Japanese)

Exponential Integral Functions $E_n(x)$ occur very frequently in shield calculations. The graphs of $E_1(x)$ and $E_2(x)$ are shown. Variables were chosen from 0 to 10. The graphical errors would be within ±0.2%. For larger x up to 20, approximate functions $Q_1(x)$ and $Q_2(x)$ are also shown. (auth)

38418 (KAPL-M-FDF-3) CALCULATED MOMENTS OF THE THERMAL NEUTRON SCATTERING KERNEL FOR WATER AND POLYETHYLENE AT A VARIETY OF TEMPERATURES. Francis D. Federighi and David T. Goldman (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 1963. Contract W-31-109-eng-52. 613p.

The first four Legendre moments of the differential energy exchange cross sections for thermal neutrons in water and polyethylene are listed. The total scattering and transport cross sections are also given as a function of energy. Nelkin's model with two modifications was used for scattering from water. The parameters describing the molecular binding of the scatterer were selected on the basis of energy exchange. A particular numerical integration scheme was used to avoid an integrable singularity in the differential cross section. The results for polyethylene were obtained using a model to describe the different molecular and atomic effects. The energy mesh includes 32 points from 0.001 to 0.625 ev. For water, the kernel was tabulated at 12 temperatures from 68 to 600°F: for polyethylene at 6 temperatures from 23 to 123°C. (auth)

38419 NEUTRON-SHIELD MATERIALS. III. ROLLING OF BORAL-INGOT INTO SHEET. Tetsuzo Atoda and Yoshihiko Sasa. Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 57: 84-9(June 1963).

Boral-ingots were proved to have favorable qualities, capable of being rolled into sheets. Boral-sheets, composed of a layer of aluminum and boron carbide mixture sandwiched between aluminum sheets, were produced successfully by rolling Boral-ingots enclosed in an aluminum frame and sheets. Hot as well as cold rolling is applicable for the sheet production. Small Boral-sheets of the size, (400 ~ 800) × (65 ~ 75) × (3 ~ 6) mm, composed of inner layer of thickness 2.0 ~ 4.6 mm and top and bottom wrappers of thickness 0.5 ~ 1.0 mm each, and larger sheets of the sizes, (800 ~ 900) × (715 ~ 1370) × (5.0 ~ 6.0) mm and 230 × 2000 × 6.0 mm, composed of inner layer of thickness 2.3 ~ 3.6 mm and top and bottom wrappers of thickness 1.2 ~ 1.6 mm each, were produced. Strength of bonding between inner layer and wrappers was found to be excellent. Comparison of boron contents of Boral-ingots and -sheets determined by analysis with those of ingots and sheets calculated from the ratios in amount of constituents of the raw materials proved the successful execution of the series of studies—the preparation of Boral-melt, production of Boral-ingot, rolling of ingot into Boral-sheet, and measurement of thermal neutron absorption coefficient. (auth)

38420 RADIATION UNITS AND CRITICAL ENERGIES FOR VARIOUS SUBSTANCES. O. I. Dovzhenko and A. A. Pomanskii (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: No. 2, 268-78(Aug. 1963). (In Russian)

Values of radiation units and critical energies are derived in accordance with current theoretical and experimental notions. An analysis of the origin of the discrepancies between the radiation unit and critical energy values presented in various papers is discussed. (auth)

Theoretical Physics

38421 EIGENVALUES OF THE NUCLEAR PAIRING HAMILTONIAN. Richard R. Chasman (Argonne National Lab., Ill.). Phys. Rev., 132: 343-5(Oct. 1, 1963).

A new technique is developed for solving Hamiltonians of the form

$$H = \sum_{k>0} \epsilon_k (a_k^+ a_k + a_{-k}^+ a_{-k}) - \sum_{k,l>0} G(k,l) a_k^+ a_{-k}^+ a_{-l} a_l,$$

where G(k,l) may have the forms: G(k,l) = G (independent of k and l), $G(k,l) = G_k G_l$, or G(k,l) = G(k,l) (nonseparable in k and l). The eigenvalues obtained with this technique are compared with the exact solutions of Kerman, Lawson, and Macfarlane. The agreement with the exact solutions is fairly good. (auth)

38422 CLUSTER FORMULATION OF THE EXACT EQUATION FOR THE EVOLUTION OF A CLASSICAL MANY-BODY SYSTEM. Jerome Weinstock (National Bureau of Standards, Washington, D. C.). Phys. Rev., 132: 454-69(Oct. 1, 1963).

An exact non-Markoffian equation is derived for the evolution of an infinite homogeneous system. This equation, which may be viewed as a time-dependent analog of the equilibrium virial expansion, may be readily applied when the forces between particles include infinite repulsions. The derivation of this equation from Liouville's equation is analogous to Mayer's derivation of the virial expansion from the partition function. In this way the formal development of nonequilibrium statistical mechanics is placed on a similar footing to that of equilibrium statistical mechanics, and a many-body problem is reduced to understanding the dynamics of isolated groups of particles. Fourier expansions and expansions in powers of the interaction potential are avoided by dealing with s-body Green functions (propagators), which are always convergent functions of the interaction potential. These functions correspond to multiplet collisions in ordinary configuration space between s isolated particles and are time-

dependent analogs of the irreducible clusters well known in equilibrium statistical mechanics. The kernel (memory) of the equation of evolution consists of a linear sum of the time-dependent irreducible clusters. The non-Markoffian behavior of the equation of evolution is, thus, directly given by the time dependence of these clusters, and is explicitly related to incompleted collisions. The equation of evolution is solved in the asymptotic limit of long times. In this limit it is found (because the kernel rapidly vanishes) that the equation reduces to a Markoffian master equation involving a scattering operator for both completed and incompleted collisions in configuration space. (auth)

38423 THREE-BODY SCATTERING OPERATOR IN NONEQUILIBRIUM STATISTICAL MECHANICS. Jerome Weinstock (National Bureau of Standards, Washington, D. C.). Phys. Rev., 132: 470-82(Oct. 1, 1963).

A method is presented for calculating the time-dependent irreducible clusters, $\beta_s(t)$, which appear in the kernel of the equation of evolution derived previously. The clusters $\beta_1(t)$ and $\beta_2(t)$, which correspond to binary and ternary collisions, respectively, are calculated in detail. They are each found to divide into the two following parts: (1) a completed collision part which corresponds to collisions which are eventually completed (scattering processes) and (2) an incompleted part which corresponds to those collisions not completed by time t. The incompleted collision parts contribute to the kernel of the equation of evolution and are shown to be relatively small when t is large. The completed collision parts, which play a central role in the theory of transport coefficients, are time-independent scattering operators in momentum space and do not contribute to the kernel. By means of the "binary-collision expansion" a systematic method is presented for the calculation of the three-body scattering operator $[\lim_{t\to\infty} t^{-1}\beta_2(t)]$ which is directly applicable to interaction forces with infinite repulsions. An approximate formula is then derived for this scattering operator in a form which can be readily used to calculate the density correction to transport coefficients which arise from ternary collisions. (auth)

38424 SOLUBLE PROBLEMS IN THE SCATTERING FROM COMPOUND SYSTEMS. R. D. Amado (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 132: 485-94 (Oct. 1, 1963).

The problem of making an exact theory of the scattering of particles from composite targets is attacked by introducing elementary particles to represent the composite systems. It is shown that if the only couplings are those between the particle representing the compound and its constituents, soluble linear integral equations, reducible to the Lippmann-Schwinger equation, can be written for the scattering of one of the constituents of the composite system. As examples, an exactly soluble three-dimensional three-body problem based on nucleon-deuteron scattering and an exactly soluble three-dimensional model of deuteron stripping are presented. Each can be reduced to exact optical models. It is proven that these equations have solutions even when the singular limit which corresponds to an exact resemblance between the elementary and composite system is taken. The method for extending the equations to three-body problems with local interactions and the relation of the equations presented here to high-energy diffraction properties of amplitudes is discussed. (auth)

38425 A STOCHASTIC INTERACTING FIELD. Johnny Max Canfield. Thesis, University Park, N. Mex., New Mexico State Univ., 1963. 41p.

Using the interacting quantum field representation which is connected to a free field by a time dependent unitary transformation, an interacting field model based on the theory of stochastic space-time was obtained. To determine the proper method for forming the stochastic value, $\underset{\sim}{\phi}(L)$, of this interacting field representation, several possibilities were examined; a unique prescription was determined by requiring a few basic principles to be satisfied. Four-dimensional stochastic averaging was examined and the unsuitability of this procedure is shown. A stochastic S-matrix, S(L), is defined, having finite (observer dependent) matrix elements of all orders. However, S(L) for quantum electrodynamics is not gauge invariant; this is because the stochastic in-fields on which it depends are not strictly micro-causal. (Dissertation Abstr.)

38426 FINITE FORMULATION OF QUANTUM FIELD THEORY. Robert Edward Pugh. Thesis, Iowa City, Iowa State Univ., 1963. 85p.

A fundamental integral equation to be satisfied by all quantum fields is proposed. It is shown that this equation determines all S-matrix elements. The axiom of microscopic causality was not assumed, and the asymptotic behavior of field operators follows from the theory. The boundary conditions imposed upon the S-matrix elements limit the types of interaction to the "renormalizable" ones. Within the framework of perturbation theory, it is proven that finite solutions exist to all orders. It is also shown how the general S-matrix elements may be determined. The CPT theorem is a simple consequence of the theory. The formalism was extended to quantum electrodynamics where it is shown that the gauge invariance of the theory is a consequence of the unitarity of the S-matrix and the Lorentz condition. The latter is imposed only on the wave functions of the photons in the asymptotic regions, not on either the operators or the state vectors. Finally, it is shown how the concept of the external field arises naturally in the appropriate physical situations. (Dissertation Abstr.)

38427 GENERALIZED STATISTICS IN QUANTUM FIELD THEORY. Heinz Scharfstein. Thesis, New York, New York Univ., 1962. 77p.

The physical requirements any field quantization scheme has to satisfy were examined, and field quantization is discussed with them in mind. All the requirements are shown to be contained in two criteria, one for integral and the other for half-integral spin fields. These criteria are natural consequences of Schwinger's variational principle. The field quantization schemes compatible with the two criteria were examined, and the connection between spin, statistics, and the two criteria was established. The various possible different quantization schemes give rise to generalized fields which obey generalized statistics, i.e., statistics other than Einstein-Bose and Fermi-Dirac. A representation of these generalized fields and their associated Hilbert spaces are discussed. (Dissertation Abstr.)

REACTOR TECHNOLOGY

General and Miscellaneous

38428 (ANL-6656) BASIC MATERIAL RESULTING FROM ANL ROCKET STUDY. C. Cohn, G. Golden, B. Hoglund, W. Loewenstein, G. Rosenberg, D. Sparks, and C. Youngdahl (Argonne National Lab., Ill.). May 1963. Contract W-31-109-eng-38. 113p.

The design and development of rocket reactors are considered. Topics included are: thermodynamic calculations of vapor pressure of uranium dioxide, uranium monosulfide, uranium monocarbide, zirconium monocarbide, beryllia, and tungsten; thermodynamic calculations of equilibrium interactions of the above materials with hydrogen or water; verification of multigroup constants used in reactor physics calculations; relations pertaining to a heat transfer parameter study; a heat transfer coefficient correlation for hydrogen; a FORTRAN-II subroutine to compute thermal properties of hydrogen; considerations pertaining to reactor control; and fuel plate stress analyses. (N.W.R.)

38429 (BAW-1285) THE MARVEL-SCHEBLER CONTROL ROD DRIVE SYSTEM DESIGN REVIEW. Final Report. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Sept. 1963. Contract AT(30-1)-3210. 25p.

The results and conclusions of a design review of the Marvel-Schebler control rod drive system are presented. The review included studies of mechanical design, electronic and electrical circuitry, component reliability, system reliability, system logic, component and logic failures, and system relationship to reactor safety. Work was not completed on the fault analysis, system packaging, and test recommendations. (auth)

38430 (EURAEC-133) PROGRAM FOR THE DEVELOPMENT OF PLUTONIUM RECYCLE FOR USE IN LIGHT WATER MODERATED REACTORS. Progress Report, April 1, 1961–July 1, 1961. J. G. Carver (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). July 15, 1961. Contract AT(04-3)-189. 6p.

The plutonium-enriched fuel element and its irradiation program are described. The criteria for locating the fuel element in the VBWR are outlined. Results are given of preliminary analysis of the fuel element. (D.L.C.)

38431 (GA-2372) MARITIME GAS-COOLED REACTOR PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1961. (General Atomic Div. General Dynamics Corp., San Diego, Calif. and General Dynamics Corp. Electric Boat Div., Groton, Conn.). Contract AT(04-3)-187. 135p.

Reactor Development. Thermal stress tests were carried out on square-annular BeO blocks, and preliminary results are given. Design and thermal analysis were carried out on the EBOR core, control element, and cooling systems. The thermal emissivity coefficient of Hastelloy X cladding was measured at surface temperatures of 1300 to 1700°F. Development of control rod drive mechanisms is continuing. A wet-or-dry refueling system is being developed for EBOR. Rotating Machinery. The modification of the 1300°F design of MGCR turbomachinery for 1500°F operation is described. Tests of the diffuser, exhaust hoods compressors, etc. are discussed. Reactor Physics. Measurements are reported of experiments on the EBOR critical assembly, and a comparison of calculated and experimental perturbations is made. The effects of water flooding on the EBOR core reactivity were studied. Heating rates were estimated in the control rods and moderator. A comparison is made of the LASL and General Atomic data for the U^{235} fission resonance integral over several energy ranges. The calculated capture-to-fission ratios α were also compared with experiment. Materials Development. The compressive strength and oxidation resistance of $BeO-UO_2$ fuel specimens were studied as functions of grain size. Some preliminary results are reported of the irradiation program. Radiation effects on the axial crushing strength of $BeO-UO_2$ pellets are tabulated. Results of BeO irradiations are also given. Creep and stress rupture tests were carried out on Hastelloy X at 1600°F in different atmospheres. The fabrication development of fuel elements and control rods for MGCR is described. Stress-rupture data are reported for several alloys. (D.L.C.)

38432 (GA-4488) HAZARDS SUMMARY REPORT FOR THE METAL ASSEMBLY. J. R. Brown and J. L. Russell (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Aug. 15, 1963. Contract DA-49-146-XZ-171. 29p.

Information required to obtain authorization to receive and use a fast critical assembly for operation with the General Atomic linear accelerator is documented. The analysis offers evidence showing that operation of the assembly will create no undue risk to the health and safety of the public or the personnel of the Laboratory. Experiments with the accelerator pulsed fast assembly will consist primarily of measurements of neutron yield and pulse shape produced by the electron pulses from the Linac impinging on the spherical metal reactor. (N.W.R.)

38433 (GAMD-1776) LIQUID NITROGEN WASH PROCESS FOR HELIUM PURIFICATION. G. B. Webb (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Oct. 26, 1960. Contract AT(04-3)-314. 21p.

A preliminary study is made of the possible use of the liquid nitrogen wash process for purifying helium for HTGR. The process would remove CO_2, H_2O, and radioactive noble gases from helium and could replace the delay and refrigerated traps in the helium purification system being considered for the plant, with savings in capital and operating costs. Relatively little development work is needed for the process. (D.L.C.)

38434 (HW-SA-3021) DECONTAMINATION EXPERIENCE WITH HIGH-TEMPERATURE IN-REACTOR TEST LOOPS. R. D. Weed (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 24, 1963. Contract AT(45-1)-1350. 18p. (CONF-102-5)

For Presentation at American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The Hanford KER-2, 3, and 4 Loops were decontaminated successfully with the following process: (1) organic film-conditioning solution, (2) nitric acid neutralizing rinse, (3) alkaline permanganate solution, (4) water rinses, (5) nitric acid solution, and (6) water rinses. Radioactivity levels before and after decontamination are given for various loop locations. The process was modified to reduce the reactor down-time: (1) alkaline permanganate solution, (2) water rinses, (3) acidic rinse, and (4) water rinses.

The KER-2 Loop was decontaminated successfully using this modified process with a bisulfate and a sulfamate acidic rinse. Precautions to be taken in the decontamination are described. (D.L.C.)

38435 (IDO-24041) DESIGN CRITERIA FOR A FAST FLUX LIQUID METAL LOOP IN THE ADVANCED TEST REACTOR. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. and Ebasco Services, Inc., New York). July 1962. Contract AT(10-1)-1075. 288p.

Criteria are presented for the Titles I and II design of the Fast Flux Loop Facility which is to be a part of the ATR. This facility, a NaK-cooled in-reactor packaged loop based on the Pratt & Whitney Aircraft PW-19 loop design, is to be used for irradiation of fast reactor assemblies under simulated fast reactor operating conditions. (D.L.C.)

38436 (NYO-10027) HYDRAULIC CONTROL ROD ACTUATOR. R. B. Hussey and C. F. Cartledge (American Bosch Arma Corp. American Bosch Div., Springfield, Mass.). [nd]. Contract AT(30-1)-2932. 106p.

An investigation was made of the conceptual feasibility and production of a prototype model of a Hydraulic Control Rod Drive Mechanism that utilizes primary reactor water as the hydraulic fluid and is sealed within the reactor pressure vessel. It is capable of controlling 2300-pound rods such as might be used in large pressurized-water reactors. By utilizing hydraulic feedback in a closed loop contained within the power unit itself, mechanical and/or electrical external feedback linkages are eliminated. The initial design embodied a large control sleeve surrounding the power cylinder. Rotational positioning of this control sleeve by the command signal, would allow selective porting along the length of the power cylinder to alter the hydraulic force in the system. Since the hydraulic feedback continuously acts to maintain equalization of the load and hydraulic forces, the position of the power piston is thus controlled. This method of control, however, was found to be not feasible due to excessive binding of the control sleeve. A new control method was established which eliminated the objectionable characteristics of the initial design without changing the basic concept of balancing the load and hydraulic forces. This new design employs a servo mechanism which operates in the hydraulic feedback loop of the system. The servo is equipped with a small control sleeve which, when positioned by the command signal, will alter the hydraulic force in the system. This change in hydraulic force causes power piston motion which, through feedback coupling, actuates the servo to re-establish equalization of the load and hydraulic forces; thus, control of piston position is achieved. Scram is initiated by a low level signal which causes release of the high pressure water below the power piston allowing control rod insertion by gravity. A built-in snubbing mechanism, which also uses primary water, decelerates the piston and rod in the last few inches of travel to insure a soft stop at "rod bottom" position. A single electrical harness connects the actuator to its control console. Rod position is continuously indicated on the control panel by a digital display of inches in $\frac{1}{4}$ inch increments. (auth)

38437 (ORNL-3483) NUCLEAR SAFETY PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1963. (Oak Ridge National Lab., Tenn.). Sept. 13, 1963. Contract W-7405-eng-26. 77p.

Progress in nuclear safety research and development is reported. Topics covered include: reactivity effects of small fuel displacements in a pool-type reactor; studies in nuclear safety of fuels outside reactors; release of fission products from out-of-pile reactor fuels; release of fission products in in-pile melting or burning of reactor fuels; characterization and control of accident-released fission products; fission-product evaluation; I_2 removal from oxidizing gases at high temperatures; attenuation of fission-product escape by intrinsic processes; nuclear safety pilot plant; nuclear safety information center; radiochemical-plant safety studies; and space safety. (J.R.D.)

38438 (TID-7653(Pt.I)) CONFERENCE ON NUCLEAR PROPULSION, MONTEREY, CALIFORNIA, AUGUST 16, 1962. (Space Nuclear Propulsion Office, AEC/NASA; American Rocket Society, New York; American Nuclear Society, Hinsdale, Ill.; and Institute of Aerospace Sciences, New York).

Twenty-two papers are presented in Part I of the first national conference on nuclear propulsion for rockets, ramjets, and space vehicles. Separate abstracts are prepared for 21 papers; the other paper was previously abstracted in NSA. Topics covered include: reactor criticality, radiation levels and analysis, propulsion control, flight safety of nuclear propulsion systems, reactor test operations and facilities, heat transfer and fluid flow, engine structures and component development, and engine and vehicle design. (N.W.R.)

38439 (TID-7653(Pt.I)(p.1)) CRITICAL ASSEMBLY EXPERIMENTS IN SUPPORT OF PROPULSION REACTOR DEVELOPMENT. J. R. Morton, III, (California. Univ., Livermore. Lawrence Radiation Lab.).

The critical assembly work in support of neutronic calculations for propulsion reactor development is being studied in both graphite and beryllium oxide moderated assemblies fueled with uranium of 93.2% uranium-235 content. Critical experiments are done chiefly to determine neutron flux distributions under various conditions and to measure resonance absorption integrals by the danger coefficient method. An evaluation is made of absorber and reflector materials. (N.W.R.)

38440 (TID-7653(Pt.I)(p.2-7)) CRITICALITY EXPERIMENTS AND CALCULATIONS FOR HIGH-TEMPERATURE, GRAPHITE-MODERATED ASSEMBLIES WITH SIMPLE GEOMETRY. A. G. Cole and R. G. Finke (California. Univ., Livermore. Lawrence Radiation Lab.).

The effect of temperature on reactivity of a bare, graphite-moderated, enriched-uranium assemblies over carbon-to-uranium-235 atomic ratio range, 583:1 to 21,690:1, and with critical temperatures ranging between 46 and 1110°F was experimentally determined. Buckling calculations were done for each assembly as critical at room temperature, and as overstacked to be critical at an elevated temperature. Calculations were carried out with the one-dimensional, neutron-diffusion code, 9-ZOOM with 18 energy groups. The difference between k_{eff} values for a high-temperature experiment, using room-temperature measurements and densities of both, provides a measure of the experimental excess reactivity at room temperature to be overcome by elevating the temperature. Since the effect of elevating the temperature is to decrease reactivity, a calculated k_{eff} for the high-temperature critical assembly lower than that for the room temperature critical assembly indicates an over-calculation of the temperature effect. The difference between such k_{eff} values, divided by the above experimental reactivity effect, provides a measure of the extent of the over-calculation. Since this contribution is a small fraction of the experimental temperature effect, the over-calculation must be due to nuclear

parameters such as the neglect of Doppler broadening of resonance levels and the inadequacy of the free gas moderator model. (N.W.R.)

38441 (TID-7653(Pt.I)(p.8-16)) A DISCUSSION OF THE CORRELATION OF CRITICAL CONDITIONS OF HOMOGENEOUS BARE REACTORS CONTAINING A RESONANCE ABSORBER. B. Pinkel, G. B. W. Young, and A. Leonard (RAND Corp., Santa Monica, Calif.).

Results are given of a correlation of the critical conditions for homogeneous bare reactors by showing the effect on reactor criticality of a material having strong resonance absorption bands. Whereas current methods for calculating the effect of various materials on the uranium requirement of the reactor involve the use of electronic computers, the simplified method presented enables calculation to be made rapidly by hand. (N.W.R.)

38442 (TID-7653(Pt.I)(p.17-28)) NUCLEAR RADIATION TRANSFER AND HEAT DEPOSITION RATES IN LIQUID HYDROGEN. M. O. Burrell (National Aeronautics and Space Administration. George C. Marshall Space Flight Center, Huntsville, Ala.).

An accurate calculation of radiation heat deposition and radiation transfer in liquid hydrogen was made. The calculations utilized Monte Carlo techniques and were for plane slab geometries and right circular cylinders with flat ends. The source (either neutrons or gamma rays) was always monoenergetic. The source for the cylinder was point isotropic and on the axis of the cylinder, while the slab source was plane parallel rays incident at any specified angle. The calculation provided statistical estimates of the transmitted and reflected number current, flux, and energy as well as the heat deposition rate as a function of depth in the hydrogen. (N.W.R.)

38443 (TID-7653(Pt.I)(p.29-34)) NEUTRON CONTRIBUTIONS TO LH_2 PROPELLANT HEATING. G. A. Graves and J. R. Streetman (Los Alamos Scientific Lab., N. Mex.).

Neutron histories were followed within liquid hydrogen propellant in order to establish the principal features of heating, attenuation, and transfer. The geometry consisted of approximately the first three feet of liquid hydrogen contained in a flat-bottomed conical walled tank placed 10 ft from an equivalent point source of reactor neutrons. The calculation also gave the energy distribution of neutrons emerging from various surfaces of the geometry employed and, by recording the locations at which each neutron's energy finally dropped below 10 kv, provided important information on the probable distribution of the 2.23 Mev gamma-ray-producing neutron captures. (N.W.R.)

38444 (TID-7653(Pt.I)(p.35-42)) RADIATION-INDUCED MOLECULAR REACTIONS IN LIQUID HYDROGEN. H. G. Carter (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.).

At least 43% of the energy deposited by radiation in liquid hydrogen is stored temporarily, mainly through the dissociation of hydrogen molecules. A large fraction of the remaining energy may be stored through inelastic collisions between energetic hydrogen atoms and molecules in the liquid. Most of the hydrogen atoms produced by radiation will be expelled for incident energy fluxes up to at least 10^{17} ev/cm^2 sec. Excited hydrogen molecules, which are apt to be formed in significant concentrations by recombination and by hydrogen atom inelastic scattering, may remain excited in the liquid for much longer than the 20 seconds or so required for the expulsion of the irradiated portion of the liquid. Extrapolation of the theoretical relaxation time indicates that the lifetime of the first vibrational level in the liquid is of the order of 100 minutes. The lifetime of excited hydrogen molecule states against emission in the liquid is of the order of seconds; however, the mean-free-path against absorption by re-excitation of the original type of hydrogen molecule state is so small that the effective rate of infrared diffusion is much less than 1 cm/sec. Hence, in the event that the partitioning of energy by super-elastic scattering goes slowly, then the walls of the liquid hydrogen tank will not be heated significantly by infrared radiation. The storage of energy in the form of excited hydrogen molecule states can be verified experimentally by the observations of infrared rays trapped in the liquid. (N.W.R.)

38445 (TID-7653(Pt.I)(p.52-68)) ENVIRONMENTAL STUDIES RELATED TO NUCLEAR ROCKET FLIGHT. Arnold B. Joseph (Division of Reactor Development, AEC); and Isaac Van der Hoven (Weather Bureau, Washington, D. C.).

Preliminary information on the time-space distributions of radioactivity indicates that the atmospheric route to man is the most direct. The very mechanisms which make it most direct also act to dilute and disperse it most readily. Preliminary studies of hypothesized radioactive introductions into the hydrologic environment indicate that the potential exposure problems are probably not as severe as in the atmospheric environment. A local area would be contaminated and like the atmosphere the physical forces on the water would tend to disperse the contaminant. But because the radioactive elements can be transposed to a biological or geochemical phase, there is a tendency to restrict freedom of movement. As a consequence, hydrologic problems are more enduring than the atmospheric problems. The terrestrial problems appear to be the least significant at present. They would be mostly local and essentially die out at the rate decay of the activity. However, an important consideration is the radioactive deposition on vegetation which may be reconcentrated in the food chain. (N.W.R.)

38446 (TID-7653(Pt.I)(p.69-73)) REVIEW OF PLUTO REACTOR TEST FACILITY DEVELOPMENT. William C. Miller (California. Univ., Livermore. Lawrence Radiation Lab.).

The history and development of the Pluto Test Facility are reviewed. Design requirements are discussed for air supply systems, air heater system, reactor transportation system, electric power systems, and safety and control systems. The facility operations that are required to perform a typical nuclear blowdown test are described in chronological order. (N.W.R.)

38447 (TID-7653(Pt.I)(p.74-81)) CONVECTIVE HEAT TRANSFER AND WALL FRICTION AT HIGH TEMPERATURE. P. M. Magee, D. M. McElligot, M. E. Davenport, and G. Leppert (Stanford Univ., Calif.).

Local heat transfer coefficients and friction factors for turbulent flow of air, nitrogen, and helium were obtained in ¼-inch diameter smooth pipes. Entering Reynolds numbers in various runs range from 13,500 to more than 200,000, the highest flow rates being accompanied by choking at the tube exit. Calculated Mach numbers in test section region vary from 0.02 to more than 0.4. Maximum tube wall temperatures range from 160 to 1890°F, wall-to-bulk temperature ratios to 2.45, and heat fluxes to 259,000 Btu/(hr) (sq ft), while gas pressure ranges from a few atmospheres to about 20. The local heat transfer and friction coefficients depend on calculated local bulk temperatures obtained from energy balances. Each test section was cali-

brated for radial and axial heat loss, with the result that over-all energy balances show agreement to a few per cent between calculated and measured gas exit temperature. Graphical results are presented for air. (N.W.R.)

38448 (TID-7653(Pt.I)(p.82-8)) ON THE HYDRODYNAMICS OF A COAXIAL FLOW GASEOUS REACTOR. Robert G. Ragsdale and Herbert Weinstein (National Aeronautics and Space Administration. Lewis Research Center, Cleveland).

Experimental measurements were made of an air-bromine coaxial flow system. Measured values of the variation of inner stream (bromine) density with axial position are compared with the analysis for both laminar and turbulent flow of the outer (air) stream. Though the additional complexities associated with flow instability and nuclear heat generation are as yet unexplored, the results presented provide necessary information about the basic mixing process in a coaxial flow gaseous reactor. (N.W.R.)

38449 (TID-7653(Pt.I)(p.89-97)) RADIANT HEAT TRANSFER TO ABSORBING GASES WITH FLOW AND CONDUCTION. T. H. Einstein (National Aeronautics and Space Administration. Lewis Research Center, Cleveland).

A two-dimensional analysis of radiation heat transfer is made for a gray gas enclosed in a retangular channel formed by two black parallel flat plates of finite length and infinite width. Results are presented for either combined convection and radiation or combined conduction and radiation for a wide range of gas flow rates and thermal conductivities. The wall temperatures are considered to be constant. To establish a reference several cases were run for radiation only, without flow or conduction. The interaction between conduction and radiation results in an increase in net heat transfer in comparison to the sum of the conduction and radiation heat transfer taken separately. For the case of radiation to a flowing gas from a constant temperature surface, the net heat transferred to the gas goes through a maximum as the gas absorptivity is increased. (N.W.R.)

38450 (TID-7653(Pt.I)(p.98-102)) EXPERIMENTAL SPECTRAL TRANSMISSIVITY OF CARBON PARTICLE CLOUDS. Chester D. Lanzo (National Aeronautics and Space Administration. Lewis Research Center, Cleveland).

To provide a means of initially estimating the required seeding densities in a gaseous reactor, a study of the transmissivity of carbon particle clouds at room temperature was undertaken using a spectrophotometer. The transmissivity of the particles is seen to be essentially independent of wavelength from 0.2 to 1.0 microns. (N.W.R.)

38451 (TID-7653(Pt.I)(p.103-9)) TWO-DIMENSIONAL DIFFUSION CALCULATIONS ON CO-AXIAL CAVITY REACTORS. Robert E. Hyland (National Aeronautics and Space Administration. Lewis Research Center, Cleveland).

From the two-dimensional calculations performed on cylindrical cavity reactors, it appears that the fuel region can be reduced in radius inside a cavity more than appeared possible from spherical results. The calculations indicate that if graphite is to be required for high temperature use, an increase in critical mass will result, though not as much as would be indicated by the use of room temperature cross sections. The calculations also show that critical mass can be reduced by using plutonium-239 rather than uranium-235. A single calculation of the effect of a nozzle opening through the reflector-moderator showed only a slight increase in critical mass. Inasmuch as heavy water is a better moderator, it would seem worthwhile to consider a possible combination of heavy water and graphite into a two-region moderator-reflector with high temperature capability and reduced neutron absorptions. In view of some of the steep flux gradients in a cavity reactor, it is estimated that transport theory would predict, in certain cases, larger critical masses than diffusion theory; this was indicated by a few preliminary one-dimensional calculations. (N.W.R.)

38452 (TID-7653(Pt.I)(p.110-14)) NASA RESEARCH ON THE COAXIAL FLOW GASEOUS NUCLEAR ROCKET. Robert C. Ragsdale and Frank E. Rom (National Aeronautics and Space Administration. Lewis Research Center, Cleveland).

The coaxial flow gaseous reactor concept is described. The essence of this scheme is that the nuclear fuel gas is injected into the reactor cavity at a much lower velocity (on the order of 1/100) than that of the surrounding hydrogen propellant. The hydrogen is heated to temperatures beyond materials limits by thermal radiation from the fissioning fuel. The containment criterion is satisfied if the initial velocity deficit provides a fuel residence time that is sufficiently (100 times) larger than that of the propellant. The problems and performance capability of the reactor are discussed. (N.W.R.)

38453 (TID-7653(Pt.I)(p.115-25)) CHOKING TWO-PHASE FLOW OF HYDROGEN: SOME IDEALIZED SOLUTIONS. R. V. Smith (National Bureau of Standards. Cryogenic Engineering Lab., Boulder, Colo.).

An analysis is made of three models of saturated two-phase fluid flow undergoing choking. Choking occurs when the vapor phase reaches sonic velocity. Three different problems are analyzed for hydrogen in order to show calculation methods. Conditions when choking occurs by other factors are discussed. (N.W.R.)

38454 (TID-7653(Pt.I)(p.126-73)) TRANSIENT TEMPERATURE HISTORY WITH UNIFORM ENERGY GENERATION FOR PLATE, CYLINDER, AND SPHERE WITH EXTENSIVE TABLES OF RESULTS. J. D. Seader (Rocketdyne. Div. of North American Aviation, Inc., Canoga Park, Calif.); and H. Wolf (Arkansas. Univ., Fayetteville).

The results are presented of an application of Laplace transform techniques to the solution of the transient conduction problem for the plate, cylinder, and sphere with uniform internal energy generation, and for the more general case where the surface temperature is maintained constant at a value different from the initial temperature of the solid. The advantage of using the Laplace transform technique is that its linearity property readily leads to a solution in terms of already available analytical solutions. Thus, existing graphical solutions can be utilized to make calculations. The solutions are calculated to six decimal places and are presented in extensive tables. Compilations of the IBM 7090 Fortran programs employed for the computations are included. (N.W.R.)

38455 (TID-7653(Pt.I)(p.173-80)) STARTUP STUDIES OF A NUCLEAR ROCKET REACTOR. PART 1. COMPUTATIONAL PROCEDURES AND EXPERIMENTAL CHECKS. Rodney S. Thurston and Ray Pollock (Los Alamos Scientific Lab., N. Mex.).

Digital codes for describing the heat transfer and flow conditions occurring during startup of a Rover reactor are discussed along with startup studies which were performed by the codes. Quasi-steady state flow equations were chosen in order to get the codes started. The first code, STUP,

was written to investigate models for two phase flow calculations and to calculate the behavior of the reflector alone as it is cooled by liquid hydrogen. Following this, HEX was written to incorporate similar heat transfer and flow relations into a complex systems code designed particularly to handle Kiwi-B type reactors. Both STUP and HEX, and a modification of STUP called TRIP, are discussed. Results are given of the temperature of hydrogen at exit plenum, pressure of hydrogen at exit plenum, and mid-plane wall temperature of aluminum block. (N.W.R.)

38456 (TID-7653(Pt.I)(p.181-90)) USE OF TANK MOUNTED BOOSTER PUMPS FOR PROVIDING NPSH FOR TURBO PUMPS OPERATING IN A RADIATION ENVIRONMENT. John DiStefano (Pesco Products Div., Borg-Warner Corp., Bedford, Ohio).

The results of a test program which was planned to demonstrate the feasibility of using a tank-mounted, all-inducer, high-speed liquid hydrogen booster pump to provide NPSH for the turbo pump in a reactor-powered vehicle are outlined. The inducer test pump, which is driven by a hydraulic motor, is described. The test demonstrates that a tank-mounted booster pump can be used to deliver boiling liquid hydrogen to the turbo pump of a reactor-powered vehicle with adequate NPSH to prevent cavitation. The booster pump exhibits extreme improvements in the cavitation parameters due to special design features, thermal properties of liquid hydrogen, and certain physical phenomena associated with tank mounted pumps. (N.W.R.)

38457 (TID-7653(Pt.I)(p.191-200)) THE WELDING OF 7000 SERIES ALUMINUM FOR NUCLEAR ROCKET APPLICATIONS. A. J. Kish (ACF Industries, Inc. Albuquerque Div., N. Mex.).

The welding of 7000 series aluminum alloys (composition includes zinc, magnesium, and copper) is considered. Welding processes evaluated include: TIG-fusion welding, TIG-faying strip welding, MIG welding, and TIG-cold wire feed welding. The most successful welding process investigated is the TIG-cold wire feed welding with modified filler composition containing lower nominal magnesium and slightly higher copper content than the conventional 7079 filler. This new filler is called Alloy 1. Problems discussed and evaluated include: heat treatment, welding variables, aging, solution treatment, notch characteristics, cryogenic behavior, pressure vessel behavior, Kiwi-B reactor pressure vessel welding, and composition effects. (N.W.R.)

38458 (TID-7653(Pt.I)(p.201-10)) THE IMPORTANCE OF ENGINE DESIGN ON REMOTE HANDLING OF NUCLEAR ROCKET ENGINES. William W. Barton (AMF Atomics. Div. of American Machine and Foundry Co., Greenwich, Conn.).

The types of remote handling equipment for assembly and disassembly of the NERVA engine are described. The close coordination of nuclear engine design and remote handling equipment design is discussed. In the case of the remote handling system for the NERVA program, an evaluation of the requirements has led to the selection of the following equipment: engine installation vehicle, overhead positioning subsystem, floor-mounted handling system, and wall-mounted handling system. A description is given of the four remote handling equipment listed above. (N.W.R.)

38459 (TID-7653(Pt.I)(p.211-19)) SOME STRUCTURAL ASPECTS OF GAMMA HEATING IN NUCLEAR ROCKETS. John O. Mingle (Kansas State Univ., Manhattan).

Gamma heating is present both during and after reactor operation since the source is the result of fission products as well as prompt gammas. In this respect the structural degradation will continue even after reactor shutdown, so that gamma heating might be a particularly cognizant problem for nuclear rockets having restart capabilities. The tensile strength of 4130 carbon steel and 6063 aluminum alloy are evaluated at average slab temperature and corrected for the thermal stresses. Equations for obtaining temperature distributions and thermal stresses in slabs are derived. (N.W.R.)

38460 (TID-7674) PROCEEDINGS OF THE NUCLEAR SUPERHEAT MEETING, NO. 8, MARCH 20-22, 1963, IDAHO FALLS, IDAHO. (Chicago Operations Office, AEC). Apr. 15, 1963. 107p. (COO-267)

Thirty-one papers are included and abstracted on nuclear superheat reactors. Topics covered include: out-of-pile superheat fuel cladding corrosion-oxidation and coolant chemistry tests; superheater fuel fabrication, irradiation, and activation results; in-core instrumentation development; steam-water separation and heat transfer; Borax-V operation experience and tests; reactor physics of superheat reactors; conceptual design of SCOTT-R reactor; and construction status of Bonus, Pathfinder, and EVESR reactors. (N.W.R.)

38461 (TID-7674(p.1-4)) DEPOSITION OF CHLORINE-36 ON SUPERHEATER SURFACES. G. M. Brown (General Nuclear Engineering Corp., Dunedin, Fla.).

The conditions which affect chloride deposition from high pressure steam were investigated. It was found that moisture in the steam causes pronounced deposition. Chloride deposition was also increased by surface defects and by lower steam velocities. (N.W.R.)

38462 (TID-7674(p.4-8)) STEAM CORROSION-EROSION TESTS ON STAINLESS STEELS. C. R. Bergen (Allis-Chalmers Mfg. Co., [Milwaukee]).

Out-of-pile corrosion-erosion tests on 304, 304L, 316, and 316L stainless steels in oxygenated-saturated and superheated steam were performed. All steels suffered some degree of intergranular attack. The net release was insignificant for the low carbon steels but was up to 60 mg/dm^2 per 1000 hr for type 304 stainless steel. (N.W.R.)

38463 (TID-7674(p.8-10)) CORROSION OF STAINLESS STEEL IN SUPERHEATED STEAM. W. E. Ruther (Argonne National Lab., Ill.).

The effect surface preparation has on corrosion of type 304 stainless steel was investigated. A disturbed surface layer improves corrosion resistance. One way to effect this layer is cold working. A dynamic corrosion test facility is being used to measure the corrosion characteristics of types 304 and 406 stainless steels. (N.W.R.)

38464 (TID-7674(p.10-11)) STEAM CORROSION TESTING OF HIGH-TEMPERATURE ALLOYS. R. K. Betts (General Electric Co. Advanced Technology Services, Cincinnati).

The program planned for evaluating high-temperature alloys, including those of Fe-Cr-Al-Y alloys and chromium-rare metal alloys, in superheated steam environments is discussed. (N.W.R.)

38465 (TID-7674(p.11-16)) OUT-OF-PILE SUPERHEAT CLADDING TESTS. G. G. Gaul (General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]).

Corrosion of isothermal and heated cladding specimens (types 304, 310, 316, 347, and 406 stainless steel, Inconel, Incoloy, Hastelloy X, and Ni-O-Nel) in out-of-pile loops is being investigated. A compositionally-disturbed layer on the steam side of high nickel alloys is being examined by

microprobe analysis. Type 406 heater sheaths exhibited no large flaws after a cycle run but some incipient spalling was apparent. Numerous fine cracks were noted in type 304 (low nitrogen, low carbon) heater sheaths. No evidence of localized attack on type 310 stainless steel VM (low nitrogen, low carbon) was present. (N.W.R.)

38466 (TID-7674(p.16)) EFFECTS OF EXPOSURE TO SUPERHEAT-OXYGENATED STEAM OF 550°C (1022°F) AND 1000 TO 3000 PSI PRESSURE UPON IRON AND NICKEL BASE ALLOYS. H. J. Pessl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Results of general corrosion tests of nickel and iron alloys in superheated steam are presented. Results are given for types 304L, 406, 430, 446, and 17-4 PH stainless steels, Hastelloy N and X, Inconel X, Incoloy, aluminum-chromium-iron alloys with and without yttrium, and PDRL-102. The samples were exposed 100 days in oxygenated steam (3 to 4 ppm oxygen) at 550°C and 3000 psi. The samples were cathodically descaled in molten electrolyte of 60 wt % sodium hydroxide and 40 wt % sodium carbonate at 560°C. (N.W.R.)

38467 (TID-7674(p.17-19)) WATER CHEMISTRY RESULTS, BORAX-V. C. C. Miles (Argonne National Lab., Idaho Falls, Idaho).

During the initial tests of Borax-V with a boiling core, the resistivity of the reactor water was 1 megohm-cm or better and the pH close to 7. During cold operation, the insoluble solid concentration was very low. Chloride concentration rose above 0.1 ppm only once. Tests showed that steam collector opening receives dry steam. (N.W.R.)

38468 (TID-7674(p.19-21)) PATHFINDER COOLANT TECHNOLOGY. C. R. Bergen (Allis-Chalmers Mfg. Co., [Milwaukee]).

The Pathfinder purification system is designed to keep the reactor water insoluble solids below 1 ppm, the chloride concentration below 0.1 ppm, the conductivity at 1 μohm, and the pH between 6 and 8.5. The purification system and makeup water treatment are described. (N.W.R.)

38469 (TID-7674(p.21-4)) ESADA VALLECITOS REACTOR CHEMISTRY PROGRAMS. R. S. Gilbert (General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]).

The specifications for conductivity and chloride concentration of the moderator water of EVESR are 1 μohm-cm and 0.1 ppm respectively. Inlet and outlet steam to the reactor will be sampled. Gas analysis for radiochemical and chemical composition will be performed. A description of the facilities used to make the water and steam measurements is included. (N.W.R.)

38470 (TID-7674(p.25-8)) BORAX-V IN-VESSEL INSTRUMENT MEASUREMENTS. E. J. Brooks (Argonne National Lab., Idaho Falls, Idaho).

Water, steam, and fuel temperatures were measured in Borax-V. The steady-state fuel temperature increased with burnup. In-core flux and coolant flow measurements were made. In-vessel foam level was also measured. (N.W.R.)

38471 (TID-7674(p.28-30)) ESADA-VESR R & D INSTRUMENTATION. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

The instrumentation necessary to measure and record fuel clad temperature and individual fuel assembly flows and pressures in EVESR is described. (N.W.R.)

38472 (TID-7674(p.31-4)) BORAX-V SUPERHEAT FUEL FABRICATION. W. C. Kramer (Argonne National Lab., Ill.).

The initial superheat core for Borax-V was completed. Two 406 stainless steel clad instrumented assemblies are being fabricated. Two advanced superheater fuel concepts utilizing spherical-shape in the fuel rods are being investigated. (N.W.R.)

38473 (TID-7674(p.34-6)) SUPERHEATER FUEL FABRICATION, IRRADIATION, AND ACTIVATION RESULTS— PATHFINDER. D. A. Patterson (Allis-Chalmers Mfg. Co., [Milwaukee]).

Thermal shock testing of superheater fuel similar to that to be used in the first loading of the Pathfinder reactor was completed. It was concluded that rupture and serious local deformation will not occur, but that high subcooling and low coolant flows can cause deformations. Development work on the cermet fuel for Pathfinder was completed. Fabrication of the ESH-4 loading for the E-SADE loop was completed. The loading has assemblies with Incoloy, type 316 stainless steel, and Hastelloy X claddings. Free standing and collapsed clad plus wire wrap and ferrule spacers were other variables included in the loading design. (N.W.R.)

38474 (TID-7674(p.36-9)) FABRICATION OF ANNULAR MULTITUBE SUPERHEAT FUEL ELEMENTS. B. E. Murtha (Combustion Engineering, Inc., [Windsor, Conn.]).

Fabrication development of annular multitube superheat fuel elements is being conducted. Successful circumferential and tube sheet welds were performed. Vibratory compaction using three sieve sizes and incremental loading has produced elements with densities 84% of theoretical. (N.W.R.)

38475 (TID-7674(p.39-45)) SUPERHEAT FUEL TECHNOLOGY. C. N. Spalaris (General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]).

The cycles to failure at different strain rates were determined for Inconel, Incoloy, and Hastelloy X. Mechanical property tests were performed on coupons which were exposed to superheated steam. Boiling magnesium chloride screening tests of stressed specimens were completed. Process development for the EVESR fuel is nearing completion. The type 304 stainless steel-clad fuel element of the ESH-1 loading of the SADE loop had intergranular cracks in its outside surface. (N.W.R.)

38476 (TID-7674(p.46-8)) STEAM–WATER SEPARATION AND HEAT TRANSFER. W. L. Fiock (General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]).

More precise values for the exponents and coefficients of generally-accepted heat transfer equations were determined for superheated steam. Steam-water and air-water carryover and carryunder tests on full circle radial vane separators have shown that the units probably will perform acceptably for a 300 and 600 Mw(e) plant. (N.W.R.)

38477 (TID-7674(p.48)) STEAM–WATER SEPARATION. W. M. Hawkins (Allis-Chalmers Mfg. Co., [Milwaukee]).

Air-water tests are being carried out to optimize the configuration of centrifugal separators. A high-pressure steam-water loop is being installed. (N.W.R.)

38478 (TID-7674(p.49-50)) SUPERCRITICAL HEAT TRANSFER LOOP OPERATING EXPERIENCE. S. N. Tower (Westinghouse Electric Corp., Pittsburgh).

Operation of a supercritical-pressure heat transfer closed-cycle loop is discussed. The major problems dis-

cussed are: pump failures, instrumentation difficulties, and galvanic corrosion. (N.W.R.)

38479 (TID-7674(p.50-1)) HEAT TRANSFER CORRELATIONS. A. A. Bishop (Westinghouse Electric Corp., Pittsburgh).

Heat transfer correlations are being obtained for supercritical pressure and high subcritical pressure conditions. There is a characteristic peak in the heat transfer coefficient in the region of the transposed critical temperature. (N.W.R.)

38480 (TID-7674(p.52-3)) BORAX-V OPERATING EXPERIENCE AND TESTS. R. W. Thiel (Argonne National Lab., Idaho Falls, Idaho).

Tests on Borax-V with a complete boiling core were concluded. The excess reactivity at operating temperature was increased over that of the initial loading by increasing the water to fuel ratio of the core. Modifications to the boric acid system had to be made. Preparations are being made for operation with nuclear superheat. (N.W.R.)

38481 (TID-7674(p.54-5)) COMPARISON OF MEASURED AND CALCULATED CLUSTER-PIN LATTICE PARAMETERS. P. S. Lacy (Allis-Chalmers Mfg. Co., [Milwaukee]).

Comparisons were made between measured and calculated uranium-238 effective resonance integrals and thermal flux distributions for clustered pin superheater lattices. (N.W.R.)

38482 (TID-7674(p.55-7)) MIXED-SPECTRUM SUPERHEAT REACTOR CRITICAL EXPERIMENT. A. B. Reynolds (General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]).

Fabrication of the Mixed Spectrum Critical Assembly components is about 80% complete. About 0.3 of the power will be generated in the fast section. Uranium-235 fuses were developed for the fast core. Reactivity coefficients were calculated. (N.W.R.)

38483 (TID-7674(p.58)) PHYSICS ANALYSIS OF THE ESADA-VESR STARTUP EXPERIMENT. M. L. Weiss (General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]).

The core physics parameters for the startup of the EVESR were calculated. Critical experiments were performed to check the accuracy of the calculations. (N.W.R.)

38484 (TID-7674(p.58-9)) CRITICAL EXPERIMENT WITH BORAX-V INTERNAL SUPERHEATER. K. E. Plumlee (Argonne National Lab., Ill.).

Power distributions, local peaking factors, and disadvantage factors were determined for Borax-V in a critical experiment. The effect of voiding the central superheater was also determined and measurements of neutron spectral indices were made. (N.W.R.)

38485 (TID-7674(p.59-60)) NUCLEAR ENGINEERING MEASUREMENTS ON CORES B-1D AND B-2 OF BORAX-V. A. W. Solbrig, Jr. (Argonne National Lab., Idaho Falls, Idaho).

The control rod worth of the initial Borax-V core decreased with increasing temperature. In the B-2 core, the reverse was true and the excess reactivity was 6.2% at operating temperature compared to 3.2% for the initial loading. Flux plots were made. An experiment to determine the relative reactivity worth of various control materials was run. (N.W.R.)

38486 (TID-7674(p.61-2)) STABILITY MEASUREMENTS ON BORAX-V BOILING CORE B-2. R. A. Cushman (Argonne National Lab., Idaho Falls, Idaho).

A rotating poison oscillator was used to perform the Borax-V stability measurements. The amplitude and phase of the reactor transfer function were measured at various powers. (N.W.R.)

38487 (TID-7674(p.63-4)) STATE OF THE ART OF REACTOR PHYSICS ON SUPERHEATING REACTORS. M. F. Valerino (General Nuclear Engineering Corp., Dunedin, Fla.).

Design calculational techniques for thermal utilization and resonance capture are compared to more vigorous machine calculations. Analyses are under way to determine the effects of water channels on k_{eff} and local power peaking. (N.W.R.)

38488 (TID-7674(p.65-6)) 1000 MW(e) SCOTT-R CONCEPTUAL DESIGN. S. N. Tower (Westinghouse Electric Corp., Pittsburgh).

In-core reheat and condensing steam reheat power cycles for a 1000 Mw(e) SCOTT-R are being studied. Plant efficiencies are 43 and 42%, respectively. Fuel cycle and unit capital costs are computed to be between 1.0 and 1.4 mills and $120/kw net, respectively. (N.W.R.)

38489 (TID-7674(p.66-7)) STATUS OF BONUS CONSTRUCTION. R. J. Impara (General Nuclear Engineering Corp., Dunedin, Fla.).

Construction of BONUS is scheduled for completion in September 1963. Preliminary design work has begun on an advanced superheater core. (N.W.R.)

38490 (TID-7674(p.67-8)) STATUS OF PATHFINDER CONSTRUCTION. R. W. Klecker (Allis-Chalmers Mfg. Co., [Milwaukee]).

Preoperational tests on the Pathfinder reactor are 70% complete. Some modifications of the plant were made. Criticality is scheduled for September 1, 1963. (N.W.R.)

38491 (TID-7674(p.68-9)) STATUS OF EVESR CONSTRUCTION. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]).

EVESR construction was 94% complete on March 1, 1963. (N.W.R.)

38492 (TID-19378) THE AECL FLUID SWITCH AND ITS CONTROL CIRCUIT. Instruction Manual. L. E. Goodwin and D. A. Nelson (Du Pont de Nemours (E. I.) & Co. Engineering Dept., Wilmington, Del.). [nd]. Contract [AT(07-2)-1]. 38p.

See CAPE-1047 for drawings.

A sample scanning valve was developed for use in a fuel rupture monitoring system. The scanning valve or fluid switch is required to accept a minimum of 40 input sample flows of coolant from the reactor and to sequentially connect these flows, two at a time, to two separate output lines. The main body of the apparatus is constructed of one 10-in. 900-lb blind flange, one 10-in. 900-lb weldneck flange, and associated piping. The port selector is driven in 15° steps by a stepping motor with its rotor inside and stator outside the tubular section of the fluid switch. The control circuit automatic, manual, and logic operations and readout equipment are described. The startup and operating procedures are outlined. (M.C.G.)

38493 (WAPD-T-1594) THERMAL NEUTRON SPECTRAL AND SPATIAL DISTRIBUTIONS IN LIGHT WATER MODERATED URANIUM LATTICES. J. Hardy, Jr., J. J. Volpe, D. Klein, E. Schmidt, and E. Gelbard (Westinghouse Electric Co. Bettis Atomic Power Lab., Pittsburgh). Apr. 1963. Contract AT(11-1)-Gen-14. 30p. (CONF-133-2)

From International Atomic Energy Agency Symposium of

Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963.

The thermal disadvantage factors for cylindrical U rods in hexagonal lattices were measured by activation techniques. Monte Carlo calculated factors obtained for these arrays with the Nelkin kernel were 4.3% lower than those obtained with the Radkowsky (free proton) kernel for a wide range of H_2O:U volume ratios. For an 8:1 ratio, the measured value agreed with the Nelkin kernel value, but for 1:1 to 2.1, this calculated value was too high. The thermal flux distribution measured in water poisoned with Cd was successfully calculated with the Nelkin kernel. The Radkowsky kernel gave a softer spectrum in disagreement with the measurements. (D.C.W.)

38494 (AEC-tr-6010) SHIELDING MEASUREMENTS ON THE ULYSSE REACTOR DURING START-UP. A. Tattegrain and H. Satge ([France. Commissariat a l'Energie Atomique, Paris]). Translated for Oak Ridge National Lab., Tenn., from report CEA-Note-414. [nd]. 19p.

Measurements are reported of the thermal, epithermal, and fast neutron fluxes and of gamma flux in the horizontal channel of the north side and in the channel of the thermal column on the west side during 100-kw operation of ULYSSE. The observed fluxes are practically zero at the outlets of the shields, and the fluxes found at the entry of the graphite reflector are in good agreement with calculated fluxes. The validity of shielding calculations by a two-group neutron theory (PENELOPE program) in various shielding materials was tested. (D.L.C.)

38495 (EURAEC-188) TRANSPORTATION OF SPENT FUELS FROM THE SENN REACTOR (ITALY). Quarterly Progress Report No. 1, February 1–October 1961. (Lebon et Cie., Paris and Société Générale d'Exploitations Industrielles, Paris). Oct. 31, 1961.

Work Performed under United States–Euratom Joint Research and Development Program. Contract 043-61-2RDF. 40p. (A translation)

The legal and technical questions raised by the transportation of spent fuels from the SENN reactor are investigated. Information is presented on Italian regulations in force, authorization procedures, insurance requirements, transportation methods and means, and questions yet to be answered. (N.W.R.)

38496 A METHOD FOR CALCULATION OF THE LONG-TIME BEHAVIOR OF THERMAL REACTORS, PRESENTED WITH AN EXAMPLE OF TWO-ZONE REACTORS. H. Horstmann (Institut für Reine und Angewandte Kernphysik, Kiel). Atomkernenergie, 8: 257-68(July-Aug. 1963). (In German)

A method for calculating long-time variations of neutron flux distribution and reactivity of a thermal reactor is described. A solution must be found for the diffusion equations for several groups of neutrons for a reactor, in which nuclear properties vary with position and time. If it is assumed that time intervals Δt can be selected, so that the flux variation d_φ/dt at the position t in the reactor is nearly constant during Δt, the calculation of the characteristics of the reactor can be performed stepwise for $t_m = m \cdot \Delta t$ ($m = 1, 2, \ldots$). Then the equations for neutron fluxes and reactivity at t_m are only dependent on position. The eigenvalue problem of these equations was solved by a finite method of differences, and by an iteration process neutron fluxes and reactivity could be determined exactly. Numerical calculations were performed for a so-called two-zone-reactor. (auth)

38497 EFFECTIVENESS OF CONTROL RODS IN MULTIPLE-ZONE REACTORS. T. B. Enginol (Institut für Reine und Angewandte Kernphysik, Kiel). Atomkernenergie, 8: 268-76(July-Aug. 1963). (In German)

A mathematical method is presented for the evaluation of the influence exerted by control rods on the criticality of a multiple-region reactor. A numerical application of this method is discussed. The analytical treatment led to a critical determinant of infinite order for which special cases were considered. By necessity, finite approximations were found which could be treated numerically. In order to estimate the resulting error it was desirable to obtain a number of solutions with increasing accuracy. Therefore a single region of the reactor was considered in such a way that the values of Φ/Φ' for the flux at the boundaries could be used as parameters in certain criticality relations for the single region. The procedure made it possible to compare the results of solutions involving various degrees of approximation. By means of the critical determinant of the whole system it was possible to calculate the change of reactivity caused by the control rods. This was done for various numbers, geometries, and diameters of the rods in a three region reactor using a computer. For this purpose the eigenvalue of the critical determinant (as the mean value of secondary neutrons per fission) had to be determined. (auth)

38498 REMARKS TO THE RESEARCH PROGRAM OF THE SEIBERSDORF REACTOR CENTER. M. J. Higatsberger (Osterreichischen Studiengesellschaft für Atomenergie GmbH, Vienna). Atompraxis, 9: 253-5(July 1963). (In German)

The construction and operation of the Seibersdorf Reactor Center and the development of the Austrian Society for Atomic Energy Studies are shown graphically, with particular reference to investments, operating expenses, and personnel from 1956 to the end of 1962. The basic principles of the research and development program, plans for special projects, and various aspects of an envisioned four-year program are presented. A combination of basic and applied research was made possible by close co-operation with various university institutes. Seibersdorf also serves as an instructional and training center. In addition, courses in reactor techniques, radiation protection, and isotopes are given there. (auth)

38499 A RADIATION-TUBE CHARGING MACHINE. E. Dinstl and E. Schindler (Osterreichische Studiengesellschaft für Atominergie GmbH, Vienna). Atompraxis, 9: 274-8(July 1963). (In German)

A machine for charging and discharging radiation tubes is described. It was especially designed for the ASTRA reactor, with the following characteristics: two axially parallel shielding tubes (AR) form a closed shield and are mounted on a motor-driven chassis with an oil-hydraulic hoist for transporting and installing the AR. Two roller devices attached to the chassis frame make it possible to move the charging machine laterally. Adjustment is made by means of a collimator and alignment telescope. During the charging process, one AR accommodates the plug. After a lateral shift, the experimental tube contained in the other AR is shoved into the radiation tube. The experimental shielding tube can be lifted from the chassis by means of a crane, and thus serves as a transport container. (auth)

38500 RADIOCHEMISTRY STUDY OF THE DISTRIBUTION OF FISSION-PRODUCT ELEMENTS IN THORIA-URANIA-WATER SLURRIES. I. Gruverman and P. Kruger (Nuclear Science and Engineering Corp., Pittsburgh). J. Nucl. Energy, Pt. A & B, 17: 233-6(Aug. 1963).

Radioactive tracers were used to determine the distribution of the important fission product elements between the solid and liquid phases of thoria–urania–water slurries and to test the efficiency of two decontamination reagents for the removal of fission products from the solid phase. The distributions were studied under simulated reactor conditions using two different fuel preparations and three fission product concentrations representing various degrees of burn-up. After determining the distribution, portions of the solids were then treated with 0.2N HNO_3 and a 5 percent solution of the sodium salt of ethylenediaminetetraacetic acid to remove the sorbed fission products. Analogous experiments were performed with reactor-irradiated slurry solids. The behavior of the fission products was found to be consistent with their general chemical properties. (auth)

38501 FIRST-COLLISION PROBABILITIES ASSOCIATED WITH LINEARLY ANISOTROPIC FLUX DISTRIBUTIONS IN CYLINDRICAL GEOMETRY. J. Hyslop (English Electric Co. Ltd., Whetstone, Leicester, Eng.). J. Nucl. Energy, Pt. A & B, 17: 237-44(Aug. 1963).

A method is developed for obtaining the probabilities associated with the linearly anisotropic component of the flux incident on the fuel region from the moderator, having in mind the well-known scheme that utilizes modified diffusion theory in the moderator and collision probability methods in the multi-annular fuel region. Exact reciprocity theorems are established for the anisotropic probabilities, which, when combined with an extension of an approximation proposed by Bonalumi (1961) for the isotropic case, enable rapid calculations to be carried out. Numerical results are given for a calculation demonstrating the range of validity of the approximations used in both Bonalumi's isotropic case and the present anisotropic work, and tables are presented which should facilitate computation. (auth)

38502 THE SYMMETRIC CREEP BOWING OF STACKED FUEL ELEMENTS. W. S. Blackburn and J. Percy (C. A. Parsons & Co. Ltd., Newcastle-upon-Tyne, Eng.). J. Nucl. Energy, Pt. A & B, 17: 257-71 (Aug. 1963).

The bowing of uranium fuel elements stacked vertically in reactors gives rise to forces on the splitters which may cause severe deformation. The case of a symmetric element whose top is held vertically above its bottom in a pin-jointed manner is considered, a detailed account being given for bowing, firstly, after the element has come into contact with two symmetrically placed restraints and, secondly, after the mid-point of the element is allowed to come into contact with the channel wall, no restraints being present. In the case of point restraints it is found that the total force on the two restraints due to the creep bowing of a fuel element whose shape is half a sine wave is initially

$$\frac{48\ Pd \sin \pi\lambda/2}{\pi^2\lambda^2(3-2\lambda)L}$$

where L is its length, $(1-\lambda)L$ is the distance between the restraints and d sin $\pi\lambda/2$ is the effective clearance; when $\lambda = 1$ this force is a minimum. The displacements of the axis from the vertical and the force on the splitters subsequently increase and for large times they are at a minimum if λ is about $\frac{2}{3}$. When the element is unrestrained and its mid-point is allowed to come into contact with the channel wall, it is found that for a period of time the element flattens itself against the wall before splitting occurs. The initial rate of moving apart of the points of contact is infinite. When the initial bow is sinusoidal, point contact is maintained for about $5\frac{1}{2}$ doubling times and the points of contact move half way to the ends after $26\frac{3}{8}$ doubling times. When the initial bow is a sine wave plus its third harmonic with $\frac{1}{9}$ the fundamental amplitude, the point of contact moves half way after $13\frac{5}{8}$ doubling times. The mid-point moves so that after 23 doubling times its distance from the line joining the centers of the ends change from 0.2 in. to 0.154 in. and to 0.0723 in. in the two cases respectively. The maximum value of the force, attained after $28\frac{3}{4}$ and $18\frac{1}{4}$ doubling times in these two cases, is in each case about $1\frac{1}{2}$ times its initial value. (auth)

38503 ON THE PARAMETRIC REPRESENTATION OF FAST REACTOR SPECTRA. G. Blaesser and E. Diana (Euratom-C.C.R., Ispra, Italy). J. Nucl. Energy, Pt. A & B, 17: 277-8(Aug. 1963).

If it is possible to represent a reactor spectrum by a small number of parameters, an integral approach can be used for each parameter configuration extending the information gained from integral experiments. The spectrum in the center of a certain number of unreflected spherical uranium-fueled fast assemblies is calculated. (R.E.U.)

38504 MEASUREMENTS OF THE MAXIMUM PERMISSIBLE NEUTRON FLUXES AT THE RESEARCH REACTOR GEESTHACHT. U. Janssen (Gesellschaft fur Kernenergieverwertung, Schiffbau and Schiffahrt mbH, Ger.). Kerntechnik, 5: 328-30(Aug. 1963). (In German)

The interpretation of neutron measurements is difficult in the radiation protection supervision of a research reactor. Slow, intermediate, and fast neutrons can be measured separately by using a BF_3 counter with and without a cadmium shield and a proton recoil counter. The dose rate of the intermediate neutrons can only be determined by assuming a 1/E distribution in the scattered radiation as well, the existence of which must always be checked. (auth)

38505 MATHEMATICAL EXERCISES IN NUCLEAR ENGINEERING. G. Mardus. Kerntechnik, 5: 331-3(Aug. 1963). (In German)

Diffusion equations for thermal flux in a parallelepiped for the given boundary conditions are presented in a continuation of previous studies. (M.C.G.)

38506 SOME REMARKS ON THE SOLUTION OF MULTI-GROUP DIFFUSION EQUATIONS. Mitsuo Shindo (Hitachi Shipbuilding and Engineering Co., Ltd., Japan). Nippon Genshiryoku Gakkaishi, 5: 555-60(July 1963). (In English)

In the analytical calculation of criticality by the 3-group method, the equation which determines buckling may have, in general, complex solutions. For the positive real buckling, the flux has the same form as is given in the usual bare reactors, and has an oscillatory character, and for the negative real buckling, the flux has an exponential character. For the complex buckling, however, the flux contains both an oscillating and an exponential part. These forms were deduced explicitly for some typical reactor geometries. No other forms of functions appear if the number of groups becomes greater than three. (auth)

38507 KINETICS OF LOW SOURCE REACTOR START-UPS. PART III. D. B. MacMillan and M. L. Storm (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 16: 369-80(Aug. 1963). (TID-16142(Pt.III))

The applicability of the zero-neutron-lifetime approximation in describing the effects of neutron-level fluctuations is investigated for reactivities near and above prompt critical. It is concluded that meaningful statisti-

cal information can be obtained by the zero-lifetime model above prompt critical, and an approximate procedure for joining this model to a deterministic finite-lifetime model is suggested. Illustrative examples, comparing numerical results obtained by this approximation with more accurate finite-lifetime statistical calculations, are presented. In addition, application is made to Los Alamos and Livermore superprompt-critical burst experiments that fall outside of the practical computing range of the finite-lifetime model. It is found that the agreement of calculation and experiment is as good as was found previously for a set of subprompt-critical burst experiments. (auth)

38508 A COMPARISON OF THE TRANSFER FUNCTION OF THE INTERNAL REACTOR LOOP FOR THE CASES OF BOTH DISTRIBUTED AND LUMPED PARAMETERS. W. Ciechanowicz (Inst. of Nuclear Research, Warsaw). Nucl. Sci. Eng., 16: 456-9(Aug. 1963).

The power-coolant temperature transfer functions obtained for cases of both distributed and lumped parameters are used to compare three models of the internal reactor loop. The power-coolant transfer functions are considered for two values of the coolant velocity, and the results as attenuation and phase characteristics are presented. After adding the attenuation and phase characteristics of the power-coolant temperature and zero power kinetics transfer functions, the open-loop frequency responses of the examples considered are obtained. Two examples of the closed loop transfer functions are also considered. It is concluded that the distributed model of the thermal processes in the reactor core allows the open loop gain coefficient to be greater in comparison with the lumped model at the same conditions of damping of the closed loop. (C.E.S.)

38509 THE FUCHS–NORDHEIM MODEL WITH VARIABLE HEAT CAPACITY. R. Scalettar (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 16: 459-60(Aug. 1963).

The computation of final fuel element temperature and peak power for a pulsed reactor with variable heat capacity is discussed. The equations of motion obtained from the Fuchs-Nordheim model are used in the derivation. (C.E.S.)

38510 THE DOPPLER EFFECT FOR A NON-UNIFORM TEMPERATURE DISTRIBUTION IN REACTOR FUEL ELEMENTS. Jack Emil Olhoeft. Thesis, Ann Arbor, Mich., Univ. of Michigan. 1963. 157p.

The Monte Carlo method was used to investigate the temperature effects on the Doppler coefficient of reactivity and resonance capture probability due to a non-uniform temperature distribution in the fuel rods arrayed in a reactor lattice. Scattering is allowed in the fuel and moderator, and Doppler broadening of the resonances is taken into account. The Boltzmann equation describes the transport of neutrons in steady state. By transforming this equation into an integral equation, the solution can be expressed as a Neumann series, for which a convergence criterion was established. It is shown that the Neumann series can be used to obtain series equivalents for general reactor parameters and their derivatives which depend on the neutron collision density. A Monte Carlo process that traces neutrons in spatial propagation and energy degradation through a reactor can be related to random walk chains governed by the source and kernel of the integral equation. Also, once the relationship between Monte Carlo histories and the Neumann series is established, the proper form for random variables which depend upon the paths of the neutron histories in order to evaluate reactor parameters and their derivatives by the Monte Carlo methods can be determined. By application of this technique a method was devised for evaluating the Doppler coefficient. As an example of this method a computer program was developed for a cylindrical cell and a fuel rod with arbitrary radial temperature dependence. Several cases for different fuel temperatures were investigated using water moderator and UO_2 fuel. Results illustrating temperature dependence of the Doppler coefficient of reactivity and the resonance capture probability are reported for uniform temperature and parabolic temperature distributions in the fuel. The results indicated that this direct method of calculating the Doppler coefficient by the Monte Carlo is practical, and allows more efficient use of computer time in comparison to empirical and finite difference approximations previously used. It was also concluded that the Doppler coefficient is more sensitive than the capture probability to a temperature distribution appropriate to power reactors. This Monte Carlo program also provides the means of investigating these same effects for temperature distributions appropriate to reactors in excursion conditions. (Dissertation Abstr.)

38511 A STUDY OF THE VARIATIONAL PRINCIPLES OF NUCLEAR REACTOR PHYSICS. Paul Wesley Dickson, Jr., Thesis, Raleigh, N. C., North Carolina State Coll., 1962. 203p.

The application of the two main uses of the variational principle to reactor physics is explored. The two uses are first, to derive exact equations of motion from a stationary Lagrangian and to study the implications of the Lagrangian regarding constants of the motion, and second, to obtain approximate solutions to non-linear differential equations. Attention is restricted to diffusion theory, and hence the results are applicable only to reactors for which diffusion theory is adequate. Lagrangians for one- and two-group diffusion theory as well as one for the one-group theory including delayed neutron effects are presented and proved to be correct. From these Lagrangians the corresponding reactor Hamiltonians are found and used to determine the "conjugate momenta" and some constants of the motion for reactor diffusion theory. The implications or interpretations resultant from these constants and the conjugate momenta are discussed. The Hamilton-Jacobi equations for the one-group Hamiltonian were derived and shown to yield the expected results. Time-dependent perturbation theory is shown to be applicable to reactor problems to determine flux functions as a function of time. Variational theory is compared to the perturbation theory when carried to higher orders for the one-group case. Two-group variational theory is discussed in general terms. A modified form of variational theory which will delineate a lower bound to an eigenvalue was applied in general form to reactor problems. The standard upper bound variational theory and its lower bound form were then applied, using a one-parameter trial function, to many specific cases whose upper bounds are known from perturbation theory. Two-parameter one-group variational theory was considered. It was found that a two-parameter trial function yields quite accurate results even for heavily loaded reactors, if the poison is not too greatly concentrated. The special case of the reflected reactor was considered, and a correction to the perturbation theory determination of $\delta k_e/k_e$ was derived. A two-parameter variational technique was applied to this same problem and the correction required for reflected reactors is discussed. Two methods of attack, using the fourth-order differential equation and the matrix

equation, on the two-group variational problem are presented. Solutions for several one- and two-parameter trial functions were determined for general poison distributions. An analytical solution for a perturbed reactor system was obtained, and the exact answer was compared with the variational answers for differential trial functions to demonstrate the validity of the method. (Dissertation Abstr.)

38512 EVALUATION OF PARAMETERS IN A TWO SLAB REACTOR BY RANDOM NOISE MEASUREMENTS. Allen Ross Boynton. Thesis, Gainesville, Fla., Univ. of Florida, 1962. 133p.

An experimental method of measuring the parameters peculiar to a two region nuclear reactor was developed requiring the measurement of the cross-power spectrum between the outputs of the two reactor regions. The relation for the cross-power spectrum between the outputs of the two regions was derived and was found to contain the transfer functions of the individual regions. These transfer functions were derived from the reactor kinetics equations for a coupled reactor system in which each fuel region is subcritical when considered separately and the coupling between regions allows the system to become critical. The cross-power spectrum between the outputs of the two regions is a complex quantity, the phase component of which is found to be sensitive to the transit time of a disturbance traveling between the regions. Both the amplitude and the phase components were found to be dependent on the values of the multiplication factors of the fuel regions. Using band pass filters and an analog computer, the cross-power spectrum between the outputs of the two regions in the University of Florida Training Reactor was measured directly under two operational conditions; a stationary random external input to one region only, and no external input to either region. These data indicated that the propagation of a disturbance from one region of the reactor to the opposite region may adequately be described in terms of neutron waves and that the method may be used to determine the multiplication factor of each region. (Dissertation Abstr.)

38513 REACTOR MATERIALS. Volume 6, No. 2. R. W. Dayton, E. M. Simons, and R. W. Endebrock (Battelle Memorial Inst., Columbus, Ohio). May 1963. 72p. $0.55(GPO)(Domestic), $0.70(GPO)(Foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 72p.

A review is presented of developments in fuel and fertile materials, moderator materials, and nuclear poisons. The bibliographies contain 188 references on properties, behavior, and fabrication processes of materials applicable to nuclear reactor components and associated equipment. (N.W.R.)

38514 REACTOR NOISE. An AEC Monograph. Joseph A. Thie. Monograph Series on Nuclear Science and Technology. New York, Rowman and Littlefield, Inc., 1963. 274p. $6.95. (TID-19391)

The theoretical basis for the various methods of noise analysis is explained, and experiments in which these methods are applied to zero power reactors are reviewed, stressing both frequency and time analysis. Equipment and procedures for data collection and analysis and applications of noise analysis to power reactors are also discussed. (D.C.W.)

38515 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Claude Hespel and Joseph Olivier (to Commissariat à l'Energie Atomique). British Patent 933,217. Aug. 8, 1963. Priority date Oct. 14, 1960, France.

A mounting device for reactor fuel element assemblies is patented. The device is particularly applicable to marine pressurized water reactors. Any kind of fuel assembly, including bars, plates, or tubes may be used in the mount, which holds the assembly rigidly in the reactor core and permits free downward expansion. The mount consists of a head in the upper grid of the reactor and a cylindrical guide tube locked into the machined bore of the head. The fuel element assembly is secured by means of flanges to the lower part of the head and to a sliding ferrule member in the lower grid of the reactor. (M.P.G.)

38516 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Anthony Francis Taylor (to United Kingdom Atomic Energy Authority). British Patent 933,382. Aug. 8, 1963. Filed Apr. 19, 1960.

A reactor fuel element having heat-transfer finning and flow-splitters intersecting the heat-transfer finning is patented. To make the fuel element stable when it is subjected to a flow of pressurized coolant, two tubular shrouding members are provided. The shrouding members, which may be metal, surround the flow-splitters at or near each end of the fuel element. Each shrouding member is at least $^1/_{20}$ the length of the flow-splitters. (M.P.G.)

38517 IMPROVEMENTS IN APPARATUS FOR MONITORING A PHYSICAL MAGNITUDE AT A MULTIPLICITY OF DISTINCT POINTS AND IN PARTICULAR FOR DETECTING BURST SLUGS IN THE CHANNELS OF A HETEROGENEOUS NUCLEAR REACTOR. Roland Cochinal (to Commissariat à l'Energie Atomique). British Patent 933,451. Aug. 8, 1963. Priority date Apr. 2, 1959, France.

A device for detecting quickly the rise above a critical level of a physical magnitude at any of a multiplicity of points is patented. The physical magnitude is measured by a single instrument. The device uses 3 programs. In the first one, the mean value of the magnitude for a group of points is measured cyclically. If this exceeds a critical value, the second program is initiated, and the magnitude is measured at each point in the defective group. When the defective point is located, the third program is used, and the defective point is monitored separately, and the rest of the points in the group and the remaining groups are monitored as in the first program. Electro-mechanical mechanisms are used chiefly to perform the switching operations for the 3 programs and to memorize the defective groups and points. The device is particularly applicable to the monitoring of heterogeneous reactors to detect leaks in slug cans. (M.P.G.)

38518 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stefan George Bauer (to Rolls-Royce Ltd.). British Patent 933,455. Aug. 8, 1963. Filed date Mar. 1, 1961.

The design of a fuel channel for a reactor is patented. The channel consists of a tube of Al, Al alloy, or Mg alloy wound with a Zr-alloy wire. The wire has a lower neutron absorption coefficient than the tube. The thickness of the tube is less than that necessary to withstand the pressure of the coolant within the tube, but the tube withstands the pressure by being wound with the wire. The channel may also have a thin coaxial inner wall of stainless steel, the space between the inner and outer walls being filled with a pressurized gas to support the inner wall against the coolant pressure. (M.P.G.)

38519 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. John Roger Scrivener Kistruck (to Babcock and Wilcox Ltd.). British Patent 933,475. Aug. 8, 1963. Filed Aug. 7, 1959.

A device for measuring the temperatures of fuel elements in reactor channels is patented. The coolant flowing through the channels must have a low electrical conductance. Electrical contacts are mounted on the wall of the channel. The fuel element is oriented as it is moved into operating position so that contacts on the fuel element, which connect to a temperature-sensitive device, engage the contacts on the channel wall. In this way, trailing leads through the charge tubes are avoided. The design of the guides to orient the fuel elements is described. (M.P.G.)

38520 NUCLEAR FUEL ELEMENT. (to Nuclear Materials and Equipment Corp.). British Patent 933,500. Aug. 8, 1963. Priority date Aug. 23, 1960, United States.

A fuel element is patented, in which the fissionable material is highly thermally conducting, protected from corrosion due to leaks in the cladding, and dimensionally stable under irradiation. The fuel element consists of a compacted mass of precoated pellets. The coatings are deformed, but not broken, during the compacting process and form a lattice with fissionable material in the cavities of the lattice. The density of the compacted mass approaches the density of a solid block of fissionable material. The pellets may be compacted by encasing them in a container of low neutron cross section, such as stainless steel or Zr alloy, and swaging or hot or cold extruding the pellet-filled container. The pellet coatings may be of metal, semi-metal, alloys, or oxides. The lattice formed by the pellet coatings helps to prevent fission products from escaping through leaks in the fuel element sheath. (M.P.G.)

38521 NUCLEAR REACTOR. Didier Costes (to Commissariat à l'Energie Atomique). British Patent 933,523. Aug. 8, 1963. Priority date May 17, 1961, France.

The design of a heterogeneous pressure-tube-type reactor with a liquid-moderator tank is patented. The internal wall of the tank is lined with canned and removable elements of solid moderator material. This provides appreciable saving in the quantity of liquid moderator used and also provides a way to release the Wigner energy stored in the solid-moderator elements. Methods for inserting, guiding, and withdrawing the elements in the interior of the reactor tank are described. (M.P.G.)

38522 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Jacques Andre Stohr and Maurice Gauthron (to Commissariat à l'Energie Atomique). British Patent 933,816. Aug. 14, 1963. Priority date Aug. 21, 1958, France.

A reactor fuel element composed of one or more pieces of fuel within a metallic sheath formed by 2 thin metal layers is patented. At least one of the layers is embossed by plastic deformation so that it follows the shape of the fuel peices. The metal layers are in face-to-face contact around the fuel pieces and are welded together to make fluid-tight seals. The parts of the layers that are in face-to-face contact may be planar or corrugated. The metal layers may be tubular, with the fuel pieces angularly spaced from one another. (M.P.G.)

38523 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Jacques Andre Stohr and Maurice Gauthron (to Commissariat à l'Energie Atomique). British Patent 933,817. Aug. 14, 1963. Priority date Aug. 21, 1958, France.

A reactor fuel element consisting of a plurality of annular fuel pieces enclosed between 2 coaxial, tubular metal layers is patented. The fuel rings may be spaced from one another or may abut one another, with neighboring rings being of unequal radial thickness and alternate rings being of equal thickness. The metal layers are deformed to conform to the surfaces of the fuel pieces and to be in contact between the pieces. (M.P.G.)

38524 IMPROVEMENTS IN OR RELATING TO SOLID MODERATOR ARRANGEMENTS FOR NUCLEAR REACTORS. Daniel Brouard, Jean-Claude Gaudez, Roger Martin, and Pierre Rouge (to Commissariat à l'Energie Atomique). British Patent 933,982. Aug. 14, 1963. Priority date May 25, 1960, France.

A solid-moderator arrangement of square cross section is patented. The arrangement consists of parallel vertical columns of moderator rods having a large vertical dimension relative to the side of their square cross section. The rods have axial channels, and clearances are provided between each column. The columns are arranged in 2 coaxial groups, the columns in the center having a smaller cross section than the outer columns. The columns consist of a series of single rods on top of each other separated by a parallelepiped briquette of moderator material of the same cross section as the rods. The briquettes have axial channels coaxial with that of the rods and form horizontal layers in the moderator arrangement. The columns are connected together by a means such as keys and keyways at the levels of the briquettes. (M.P.G.)

38525 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Jacques Andre Stohr and Claude Bridoux (to Commissariat à l'Energie Atomique). British Patent 934,009. Aug. 14, 1963. Priority date Oct. 18, 1960, France.

A process for the fluid-tight closure of reactor fuel elements sheathed with fritted materials is patented. A concave plug is placed inside the end of the sheath. A flash weld is made simultaneously between the plug, sheath, and a member overlying adjacent ends of the sheath and plug. The member is then removed by machining. The plug may either be threaded and screwed into the sheath before welding or tapered and driven into the sheath before welding. (M.P.G.)

38526 IMPROVEMENTS RELATING TO NUCLEAR FUEL ELEMENT ASSEMBLIES AND NUCLEAR REACTORS INCLUDING SUCH ASSEMBLIES. (to Babcock and Wilcox Ltd.). British Patent 934,031. Aug. 14, 1963. Priority date May 10, 1961, Germany.

A reactor fuel element assembly consisting of a graphite sleeve containing a cluster of fuel elements is patented. The fuel elements are positioned to their ends by one or more rings at each end of the sleeve. When the assembly is placed end-to-end with a similar assembly, adjoining ring surfaces permit laminar flow of coolant through the sleeves. The rings have a hollow, semi-elliptical cross section. (M.P.G.)

38527 IMPROVEMENTS IN HOMOGENEOUS NUCLEAR REACTORS. (to Allmanna Svenska Electriska Aktiebolaget). British Patent 934,223. Aug. 14, 1963. Priority date Dec. 22, 1959, Sweden.

A method of controlling the reactivity of a homogeneous boiling reactor is patented. The reactor contains heavy or light water as a moderator with fissile material dissolved or dispersed in at least part of the moderator. Steam is produced by the moderator, and heat is removed from the steam during condensation in the primary steam circuit.

The reactor vessel is connected to at least one vessel, in which the fuel can not become critical, and the moderator is distributed between the reactor vessel and the subcritical vessel. The distribution of the moderator is controlled by regulating the pressure of the gas phases in the respective vessels with a gas flowing between the vessels and points in the primary steam circuit. The gas conduits contain adjustable regulators to resist the flow of gas. (M.P.G.)

38528 DEVICE FOR SEPARATING FROM THEIR JACKETS IRRADIATED NUCLEAR FUEL SLUGS. Pierre Dabernard and Rene Guilloteau (to Commissariat à l'Energie Atomique). British Patent 934,622, Aug. 21, 1963. Priority date June 13, 1960, France.

A device for separating reactor fuel slugs from rigid containing jackets is patented. The device consists of a carriage supporting cutting tools for cutting the jacket along 2 longitudinal lines and a separator, which has a fixed aperture through which the slug can pass but not the jacket. The cutting-tool carriage and a member for pushing the slug through the aperture are operatively connected to 2 coaxial pistons belonging to the same jack. A hopper, which is automatically retracted from the path of travel of the carriage during the cutting operation and then returned to position, receives the jacketed slugs and guides them into the correct position at the separator. (M.P.G.)

38529 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR RELEASABLY SUSPENDING A NUCLEAR FUEL ELEMENT. George Ralph Anthony Metcalfe and Harold Alan Brown (to United Kingdom Atomic Energy Authority). British Patent 935,025. Aug. 28, 1963. Filed date Aug. 11, 1960.

Apparatus for releasably suspending a reactor fuel element from a support above a reactor core is patented. The cluster-type fuel element is carried between shock-absorbing springs by a body part, which engages the support by displaceable latch members. The apparatus is especially suitable for an organic-cooled and -moderated maritime reactor, the design and operation of which is described. (M.P.G.)

38530 NUCLEAR REACTORS AND FUEL ROD SLEEVES THEREFOR. Andre Huet. British Patent 935,092. Aug. 28, 1963. Priority date Dec. 15, 1958, France.

Reactor fuel rods with double-walled sleeves and the reactor using the fuel rods and sleeves are patented. The elongated sleeve surrounds a fuel rod, providing a central passage for the flow of coolant over the fuel rod and an annular passage also for coolant flow. The annular passage is closed at the fluid outlet end except for apertures connecting the annular passage to the central passage. Apertures may also be provided about midway between the ends of the sleeve. The walls of the sleeve may be cylindrical, have transverse corrugations, or be partially conically divergent and partially conically convergent. The annular coolant passage prevents heat transfer to the moderator surrounding the fuel channels. (M.P.G.)

38531 IMPROVEMENTS IN FUEL ELEMENT ARRANGEMENTS FOR NUCLEAR REACTORS. Arthur Paul Pedrick. British Patent 935,130. Aug. 28, 1963. Filed Sept. 12, 1961.

A method of disposing spherical fuel elements in a reactor is patented. The fuel elements are arranged one above another in vertical tubes, through which the fluid coolant flows. The tubes have a plurality of necks or constrictions at regular intervals in their bore to produce regular variations in the rate of flow of coolant. These variations in rate of flow sustain a column of fuel elements, so that they gyrate at regularly spaced vertical positions in the tube. The fuel elements are supported only by the fluid friction effect of the coolant flow, and they come in contact with each other or with the sides of the tube only intermittently, if at all. The fuel elements may have a perforated outer shell filled with granules of fissionable material. The granules are too big to pass through the shell and do not completely fill the shell, so that they may be moved around by coolant flowing through the perforations in the shell. (M.P.G.)

38532 IMPROVEMENTS IN OR RELATING TO HEAT TRANSFER ARRANGEMENTS. Michael Carl Hartnell-Beavis (to General Electric Co. Ltd.). British Patent 935,464. Aug. 28, 1963. Filed June 19, 1961.

A heat-transfer arrangement especially applicable to reactor-fuel-element cans is patented. One object of the invention is to provide a reduced impedance to coolant flow for given heat-exchange characteristics. The heat-transfer arrangement or fuel-element can has longitudinal splitters radiating from the surface to define separate passages for the flow of cooling fluid. Heat-exchange fins also radiate from the can between the splitters, do not extend radially as far as the splitters, and are inclined to the direction of coolant flow. Cylindrical partition members extend longitudinally in the passage at the tips of the heat-exchange fins. Baffle members extend transversely as far out as the splitters and are inclined to coolant flow in an opposite manner from that of the fins. Fluid can pass between zones and passages defined by the splitters, partition members, and baffles. (M.P.G.)

38533 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS AND TO FUEL ELEMENTS THEREFOR. William Fairhurst, Thomas John Heal, and Ian Hugh Morrison (to United Kingdom Atomic Energy Authority). British Patent 935,510. Aug. 28, 1963. Filed Dec. 8, 1960.

A process in the fabrication of reactor fuel elements that prevents relative movement between the fuel and its sheath is patented. The fuel element is composed of U or a U-base alloy sheathed in a Mg-base alloy of fine grain size. At a temperature that does not encourage uncontrolled grain growth, the sheath is pressurized into grooves in the fuel. The assembly is allowed to cool and then annealed at a temperature substantially above that at which the fuel element is intended to operate. For fuel elements intended to operate at temperatures up to 350°C, the sheath material is recrystallized to produce fine grain size. For fuel elements operating above 350°C, the sheath material is recrystallized to obtain grain size stability. The fuel elements are especially suitable for use in gas-cooled graphite-moderated reactors. (M.P.G.)

38534 IMPROVEMENTS IN OR RELATING TO PRESSURE VESSELS. (to Babcock & Wilcox Co.). British Patent 936,170. Sept. 4, 1963. Priority date Nov. 21, 1960, United States.

An improved closure flange for a large pressure vessel, such as a vessel for a pressurized water reactor, is patented. The flange construction eliminates the disadvantages, which are inherent in very thick flanges, of slow rate of temperature change and high probability of imperfections in the flange metal. The flange is for the pressure vessel and for its closure cap and is formed with an internal annular passageway. An aperture provides access to the passageway from outside the flange. The passageway may be formed by a tubular ring of metal embedded in weld

material machined to a desired flange shape, or it may be formed between rings welded together to form the flange. Means are provided for heating or cooling the flange utilizing the internal passageway. (M.P.G.)

38535 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR COOLANT SYSTEMS. Donald Carroll Schluderberg (to Babcock & Wilcox Co.). British Patent 936,518. Sept. 11, 1963. Priority date June 21, 1960, United States.

A fluid-coolant system for a reactor core contained in a pressure vessel is patented. The coolant circulates around a closed circuit with a heat exchanger and the core in series. The coolant is a mixture of a carrier gas and fine solid particles, the concentration of which in the gas can be varied by passing the coolant through a bypass circuit. The bypass circuit contains a means for separating the coolant into heavy and light phases and selectively returning the heavy or light phase to the coolant circuit to increase or decrease the concentration of solid particles in it. A control system, responsive to coolant temperatures at the inlet and outlet of the pressure vessel, automatically varies the concentration of particles in the coolant to maintain constant coolant temperatures at the inlet and outlet. (M.P.G.)

38536 IMPROVEMENT IN NUCLEAR REACTOR CONTAINMENT APPARATUS. (to General Electric Co.). British Patent 936,626. Sept. 11, 1963. Priority date Feb. 24, 1959, United States.

An improved nuclear containment structure, including means for terminating a nuclear reaction and absorbing heat after an accident, is patented. The reactor is enclosed in a sealed inner container. An outer container surrounds the inner container and holds a pool of liquid between the containers. In an emergency liquids from the reactor can be emptied directly into the pool, and liquid from the pool can be introduced into the reactor core to absorb heat and make the core subcritical. The pool liquid is alkaline to increase the absorption of acidic fission products. (M.P.G.)

Power Reactors

38537 (ANL-6689) ZERO-POWER EXPERIMENTS WITH BOILING CORE B-1, BORAX-V. (Argonne National Lab., Idaho Falls, Idaho). June 1963. Contract W-31-109-eng-38. 82p.

Results are reported of the zero-power operation of the initial boiling core B-1 from room-temperature, atmospheric pressure conditions at 489°F and 600 psig. The core characteristics which were measured are critical mass, control rod calibrations, excess reactivity, shutdown reactivity margin, reactivity effects of various core components, reactivity effects of temperature and voids, neutron flux and power distributions, and cadmium ratios. Some development and calibration work was done on a rotating oscillator rod. It was estimated that the rated full power of 20 Mw(th) probably could not be achieved, and therefore core changes were started for core B-2, designed to achieve more available excess reactivity. (D.L.C.)

38538 (BAW-1258) VAPOR SUPPRESSION TEST PROGRAM REPORT. R. C. Luken and C. A. Leeman (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Aug. 1962. Contract AT(30-1)-2468. 91p.

The Vapor Suppression Test Program conducted under the NS Savannah Upgrading Program demonstrated that the containment of a reactor and its primary system will operate under water, and that a water-filled containment has definite advantages over a standard dry containment. A test facility was constructed to obtain information on condensation, shock formation, and impact forces resulting from an under water pipe rupture. Forty-six rupture tests were conducted with 1-, 2-, 3-, and 6-inch-diameter ruptures. Primary system pressures ranged from 500 to 1950 psig, and temperature ranged from ambient to 600°F. Complete condensation was obtained in all rupture tests with horizontal discharge. In the 1-inch rupture tests with the discharge directed vertically upward, condensation was complete with two feet of water above the rupture. The shock pressures generated in the containment water are small. The shock pressure front was not steep-fronted, but sinusoidal shaped. A theoretical method for predicting the magnitude of the maximum overpressure was developed and compares favorably with test results. The maximum shock pressure recorded from a 6-inch rupture in a system operating at 1750 psig and 500°F was 68 psig. The duration of the 68 psig pulse was <0.5 msec. The maximum pressure of any significant duration was 40 psig at 43 inches from the rupture. The impact force of the effluent discharging from the rupture is sharply attenuated with distance owing to the wide divergence of the jet. The initial angle of divergence is about 120 degrees, and the axial penetration is less than eight rupture diameters. The maximum recorded impact pressure (147 psig) occurred at a distance of 12 inches from a 3-inch diameter rupture in a system operating at 1750 psig and 510°F. The pressure lasted for about 50 msec, followed by pulsations of lesser magnitude. (auth)

38539 (CVNA-191) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. RESEARCH AND DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT, APRIL–JUNE 1963. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Contract [AT(30-1)-2289]. 35p.

Development and operation of the Carolinas-Virginia Tube Reactor are reported. Topics covered include: coolant pressure drop studies, radiation analysis, calculation of flow distribution, installation of the flux wire mapping system, evaluation of flux wire activation, ultrasonic inspection of pressure tubes, and metallurgical examination of reactor components. (N.W.R.)

38540 (DP-855) HEAVY WATER MODERATED POWER REACTORS PROGRESS REPORT, MAY–JUNE 1963. R. R. Hood and L. Isakoff, comps. (DuPont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Aug. 1963. Contract AT(07-2)-1. 44p.

The HWCTR was operated at power for about 30% of the May-June period. Operation of the reactor was preceded by completion of a shutdown period, during which iodine absorbers were installed, the containment building leak-tightness was improved, the liquid-D_2O isolated coolant loop was put into operation, and other maintenance work was performed. During irradiation testing in HWCTR, three oxide fuel tube failures were experienced due to as-yet-undetermined causes. At Columbia University, additional data were obtained on the heat transfer limits associated with the forced flow of boiling water in rod clusters and internally heated tubes. (auth)

38541 (DPR/INF/272) NUCLEAR FUEL COSTS IN EUROPE. J. L. Gillams (United Kingdom Atomic Energy Authority, London). July 1963. 7p. (CONF-193-2)

From 8th Nuclear Congress, Rome, June 1963.

A brief review is presented of fuel costs for nuclear power plants in Europe. Both natural and enriched uranium are considered, and the variables involved in the cost analysis are discussed. Long-term trends in fuel fabrication and management are considered. It is concluded that nuclear fuel costs are already low for natural-uranium reactors and should decrease further in the future as improvements are brought about in fuel element design and fabrication. (D.L.C.)

38542 (EUR-330.i) CONTRATTO DI PARTECIPAZIONE EURATOM-SIMEA PRIMA RELAZIONE ANNUALE. (EURATOM-SIMEA Contract of Participation. First Annual Report). (Società Italiana Meridionale Energia Atomica, Latina). 1963. 85p.

The SIMEA nuclear power plant has a CO_2–graphite reactor of the Calder Hall type. The construction done in 1962 on this power plant is described in some detail. By the end of the year most of the civil engineering and the mechanical and electrical installations were completed. The testing sequence to be followed is outlined. An appendix gives the procedure for the first fuel loading. (J.S.R.)

38543 (GEAP-4226) CONCEPTUAL DESIGN OF A 565 MW(e) FAST CERAMIC REACTOR. H. E. Dodge, W. W. Kendall, W. A. Sangster, and A. G. Silvester (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 1963. Contract AT(04-3)-189. 36p.

The conceptual design of a large tank-type power reactor was developed to provide perspective to the Fast Ceramic Reactor program. It was used to assess the effect of fission product release to the primary coolant system and the possibility of venting the fission products. A description is given of the mechanical and plant layout aspects of the design. (D.L.C.)

38544 (GEMP-239) DESCRIPTION OF A 10,000 SHP 630A MARITIME NUCLEAR STEAM GENERATOR. (General Electric Co. Advanced Technology Services, Cincinnati). Sept. 20, 1963. Contract AT(40-1)-2847. 226p.

The 10,000 SHP 630A Nuclear Steam Generator consists of an air-cooled, light water-moderated, beryllium-reflected reactor using metallic fuel elements, a once-through water tube boiler, two axial-flow blowers, lead and water shielding, controls, and necessary auxiliary equipment. The system is designed to replace the boiler of a conventional ship; no other propulsion equipment need be replaced nor modified. The 630A is about 31 ft high and 15 ft in diameter; it weighs about 312 tons. The main blower pumps the coolant air through a flow passage to the reactor inlet. Passing through the reactor core at 400 psi, the air is heated to 1200°F. The air then passes over the boiler where its heat is extracted to produce steam at 880 psia and 950°F in the boiler. Leaving the boiler, the air returns to the blower, thus completing the cycle. The core consists of 37 fuel cartridges, each of which is composed of nine concentric-ring fuel elements; there are quite similar in design to fuel elements developed and produced during the ANP program. A summary of four of the power plants that were developed or designed by GE-ANPD (HTRE-1, -2, -3, and XMA-1A) is given. The 630A reactor is similar to the HTRE-1. (N.W.R.)

38545 (IDO-28612) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. Quarterly Progress Report, April 1–June 30, 1963. (Aerojet-General Nucleonics, San Ramon, Calif.). Aug. 15, 1963. Contract AT(10-1)-880. 69p.

The ML-1 power plant did not operate during the report period. The defueling and disassembly of the reactor package was completed and the leak in the pressure vessel identified, as anticipated, as the failure of the lower plenum cap shear pin weld. Disassembly and inspection of the CSN-1 turbine-compressor set revealed cracking in essentially all of the turbine blade roots. The program for repair of this unit was initiated. The repair and assembly of the TSC-670A was completed and open cycle testing was initiated. The testing of a mock-up of the ML-1 pressure vessel was interrupted by a failure of the moderator circulation pump. The examination of the IB-8T-2 (10,000-hour ML-1-I prototype) test element did not reveal any evidence of second phase formation which caused severe embrittlement in an earlier test element. The test irradiation of the IB-17R-1 (instrumented ML-1-II prototype) was concluded on schedule and the IB-17R-3 (uninstrumented ML-1-II prototype) was inserted in the GETR loop. The analysis of IB-17R test data indicates that the turbulence promoters perform essentially as predicted. (auth)

38546 (MND-M-2935(Vol.II)) PM-1 NUCLEAR POWER PROGRAM. VOLUME II. PLANT PERFORMANCE STUDIES. Final Periodic Report, September 1, 1962 to December 31, 1962. (Martin-Marietta Corp. Aerospace Div., Baltimore). Apr. 1963. Contract AT(30-1)-2345. 316p.

Data obtained during the performance testing of the PM-1 plant were compiled and evaluated. The plant powers an Air Defense Command radar station located at Sundance, Wyoming, and is required to supply extremely high-quality electrical power (minimum of frequency and voltage fluctuations) even during severe load transients. The data obtained were compiled into the following format: (1) operating requirements; (2) startup requirements; (3) plant as an energy source; (4) plant radiation levels and health physics; (5) plant instrumentation and control; (6) reactor characteristics; (7) primary system characteristics; (8) secondary system characteristics; and (9) malfunction reports. It was concluded from the data that the plant performance in general meets or exceeds specification. Transient and steady-state electrical fluctuations are well within specified limitations. Heat balance data for both the primary and secondary system agree reasonably well with design predictions. Radiation levels are below those anticipated. Coolant activity in the primary system is approximately at anticipated levels; secondary system coolant activity is negligible. The core life was re-estimated based on as-built core characteristics. A lifetime of 16.6 Mw-yr is predicted. (auth)

38547 (NP-13088) CONNECTICUT YANKEE ATOMIC POWER COMPANY NUCLEAR POWER PLANT— UNIT NUMBER ONE, HADDAM, CONNECTICUT. PRELIMINARY HAZARDS SUMMARY REPORT. (Connecticut Yankee Atomic Power Co., Boston). Sept. 1963. 259p.

The information necessary to provide a basis for evaluating the safety of the Connecticut Yankee Atomic Power Plant is presented. A description is given of the site, containment, reactor design, steam supply systems, shielding, instrumentation and control, and secondary systems. The testing, operation, administration, and training programs are described briefly. Finally, accidents and potential hazards are considered, and the maximum credible accident and a hypothetical accident are analyzed. (D.L.C.)

38548 (RT/EC(62)5) ANALISI PRELIMINARE COMPARATIVA TECNICA ECONOMICA DEI REACTTORI AD

ACQUA PRESSURIZZATA, AD ACQUA BOLLENTE, A LIQUIDO ORGANICO, A GAS GRAFITE PER POTENZE DI 10–30 MWe. (Preliminary Comparative Analysis of Technical and Economic Data for Pressurized Water, Boiling Water, Organic Liquid and Gas Graphite Reactors from 10 to 30 MWe Power). S. Pittori and F. Gazzabin (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Dec. 1962. 58p.

There can be various solutions to the choice of the most economical type of reactor, according to the power range envisaged. This report, prepared by C.N.E.N. for the Greek Atomic Energy Commission, is intended to make a preliminary confrontation between the characteristics of the four types of reactor that are at present most widely studied and built, viz. the BWR, PWR, GCR, and organic reactors, for capacities of about 30 Mwe, thus making possible a comparative assessment and consequently a criterion for the choice. The report summarizes the principal technical and economic data with respect to the four types examined, always referring to the same power range. (auth)

38549 (RT/ING(63)8) IL PROGRAMMA DI RICERCA E SVILUPPO DEL REATTORE PRO. (Research Program for the Development of the PRO Reactor). S. Barabaschi and A. Bracci (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Apr. 1963. 32p.

The C.N.E.N. activity in the Organic Program is described. This activity of research has been developed in the following directions: the activity concerning the planning of the reactor prototype of Brasimone, the research for the development of advanced cores for the PRO reactor, and the basic technological research in the field of the organic-cooled reactors. (auth)

38550 (SL-2008) ENGINEERING STUDIES HEAVY WATER MODERATED POWER REACTOR PLANTS. (Sargent and Lundy, Chicago). June 30, 1963. Contract AT(38-1)-213. 295p.

Design and economic aspects of 300-, 500-, and 1000-Mw(e) heavy water-moderated power reactors are illustrated and the computer codes used in the analyses are discussed. The plant concepts all use pressure tube type reactors with cold heavy water as moderator and are cooled by: liquid heavy water, boiling heavy water, organic liquids, and light water fog. The liquid heavy water-cooled and organic-cooled reactors are used in an indirect cycle while the boiling heavy water- and light water fog-cooled reactors operate in a direct cycle. The use of large heavy water-moderated reactors as an energy source in desalination plants which would produce electrical power and fresh water is evaluated. Cost estimates together with several illustrations of the plant designs for this application are presented. (N.W.R.)

38551 (SRO-93) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, AUGUST 1963. (Savannah River Operations Office, AEC). 10p.

A refueling machine and boiler for CANDU are described, along with the testing of these components. The operations and testing of CVTR and HWCTR are outlined. The feasibility of a Th–U^{233}-fueled, D_2O-moderated power reactor is discussed. Mechanical properties and radiation testing of alloys (e.g., Inconel, Monel, Zircaloy-2, SAP, Zr–2.5% Nb–0.5% Cu) are reviewed. (T.F.H.)

38552 (SWRI-5-1348-7-1) EVALUATION OF THE SERVICEABILITY OF THE ELK RIVER REACTOR PRESSURE VESSEL. Progress Report No. 1, June 1, 1963–July 31, 1963. David W. McDowell, Jr., José McDonald, Jr., and William E. Oakey (Southwest Research Inst., San Antonio). Aug. 30, 1963. Contract AT(11-1)-1228. 47p.

The development of a program for evaluating the serviceability of the Elk River Reactor pressure vessel by determining the effect of fabrication procedures, irradiation, dissimilar weld metallurgy, and geometry on the fatigue life and nil-ductility transition temperature of the completed vessel is described. The development of remote nondestructive testing procedures for critical locations in the pressure vessel is discussed. Results are presented of studies of fatigue properties of steels and welds, and of neutron-irradiation effects on these steels. (T.F.H.)

38553 (WCAP-6055) YANKEE CORE EVALUATION PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1963. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). July 1963. Contract AT(30-1)-3017. 194p.

The status and results of the core examination work performed to date are given. The first phase of the irradiated fuel transportation effort is described. Early efforts on the revision of the design methods are discussed. Results are given on underwater examination and disassembly operations on 10 of the 14 Core I irradiated fuel elements; gamma scans on the fuel assemblies, hot cell examinations of 34 fuel rods; preliminary evaluation of chemical and radiochemical analyses on crud samples from fuel assemblies; metallurgical and metallographic evaluation on fuel assemblies; appearance and dimensions of irradiated fuel assemblies and rods; and cladding and uranium dioxide evaluations. Progress is reported on the development of a computer code to facilitate the evaluation of isotopic composition data obtained on the spent fuel samples, adaptation of fuel depletion computer programs, methods by which actual heterogeneous systems may be synthesized into an equivalent homogeneous system, and planning of critical experiments which will assist in specifying procedures for representing discontinuities in the uniform lattice. (N.W.R.)

38554 REGULATION AND INSTRUMENTATION OF FAST REACTORS. P. Dosch (Kernforschungszentrum, Karlsruhe, Ger.). Arch. Tech. Messen, Lfg. 326, p.25-30. (Mar. 1963). (KFK-146). (In German)

In the control system of a nuclear power plant, there are two principal modifications with respect to the control system of conventional power plants. The first is that the power produced is measured directly by neutron flux measurements. Secondly, because of the possibility of a fast power increase to high values, a safety system is superposed on the control system. This safety system prevents temperature rises to unpermitted values, in reactor turbulences, by rapid reduction of the power produced. Both these types of special monitoring devices are described briefly with special emphasis on the difference between the requirements for fast reactors and thermal reactors. (J.S.R.)

38555 TEMPERATURE DISTRIBUTION IN A FUEL PELLET DURING AFTER-HEAT PRODUCTION, CENTRAL-SYMMETRICAL PART. W. Binner. Atompraxis, 9: 265-70(July 1963). (In German)

One of the questions posed by cooling-system failure in a pebble reactor is that of temperature changes in a fuel pellet. It is assumed that quick-action closure of the reactor takes place as soon as the circulation blower fails, and that the heat output immediately sinks to about 10% of the original value, later decreasing exponentially as a re-

sult of after-heat production. On the conservative assumption that no heat is lost by radiation to the surrounding pellets, the temperature was calculated in a general manner, as a function of position and time, for the central-symmetrical part and for constant thermal values. The problem was traced to an orthogonal-series development with the aid of the Green function, and was solved by use of the Laplace transformation. (auth)

38556 BASIC PROBLEMS IN EVALUATING POWER REACTOR SAFETY. Ryo Ikegame (Tokyo Electric Power Co., Inc.). Nippon Genshiryoku Gakkaishi, 5: 593-600 (July 1963). (In Japanese)

Basic problems involved in the safety evaluation of power reactors are reviewed. The evaluating practice in Japan is considered satisfactory for the basic requirements in solving the sociological aspects of reactor hazards. The safety evaluation procedures taken in over-seas countries are reviewed from the standpoint of empirical probability and taking the conditions in Japan into consideration, an attempt was made to find a direction in which to proceed. The ground rules or the paths to be followed in safety evaluation propose to introduce a consideration of the probability of more serious accidents. (auth)

38557 SOME ASPECTS OF OPTIMIZATION OF ORGANIC COOLED REACTORS. Tadeusz J. Swierzawski (Silesian Inst. of Tech., Gliwice, Poland). Nukleonika, 8: 149-55(1963). (In English)

The problem of power requirements for pumping the organic coolant through the reactor core is discussed. It was found that the heat transfer coefficient from a heated wall to Santowax OMP decreases with an increase of degradation product-content in the coolant. If the nuclear reactor produces a constant amount of heat and if the wall and coolant temperatures stay constant, the heat transfer coefficient for any value of coolant degradation products (DP) content should also remain constant. It was also found that higher velocities are required for higher coolant DP content to maintain the heat transfer at the same level. The pumping power (for fixed geometry) increases very rapidly with increasing percentage DP in the coolant. At 35% DP the pumping power requirement is twice as great as that for unirradiated material with DP content equal to zero. The optimal DP content in the coolant should be kept approximately equal to 15%. Economics of the organic coolant is also discussed. (P.C.H.)

38558 ON THE THERMODYNAMIC CYCLES IN BOILING WATER NUCLEAR PLANTS. Cesare Codegone. Termotecnica (Milan), 17: 211-13(1963). (In Italian)

In nuclear power plants with boiling water reactors, the production of low-quality steam can require thermodynamic cycles with isenthalpic channels for the liquid, which do not follow the Rankine-Clausius cycle and have functional singularities. The characteristics of such cycles with one or more successive channels are described. The thermodynamic theory is developed using Mollier diagrams, and expressions for the specific thermal yield are obtained for the various cases examined. (tr-auth)

38559 POWER REACTOR TECHNOLOGY. Volume 6, No. 2. Walter H. Zinn (General Nuclear Engineering Corp., Dunedin, Fla.). Mar. 1962. 86p. $0.55(GPO) (Domestic), $0.70(GPO)(Foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 85p.

A review is presented of power reactor developments. Topics covered include: AEC report to the President; reactor physics; heat transfer and fluid flow; fuel elements; reactor materials; component technology; operating experience of Shippingport, Dresden, and boiling reactors; steam-water separation; and Hallam power reactor development. 168 references. (N.W.R.)

38560 ADVANCED PWR NUCLEAR SHIPS. BASED ON N. S. SAVANNAH EXPERIENCE. G. Arra (Cantieri Riuniti Dell'Adriatico, Trieste, Italy) and C. W. Hasek, Jr. 26p. (CONF-148-1; BAW-191)

From Symposium on Nuclear Ship Propulsion, Turin, Oct. 1962.

Information on the design and construction of nuclear ships, obtained primarily from the design, building, and testing of the N. S. Savannah, is presented. Some improved reactor designs for ships of various sizes and types are included along with suggested reactor installations. (D.C.W.)

38561 IMPROVEMENTS IN AND RELATING TO NUCLEAR POWER INSTALLATIONS. David John Ingram (to General Electric Co. Ltd.). British Patent 936,028. Sept. 4, 1963. Filed Nov. 26, 1959.

A simplified design for a power reactor installation using a reactor, such as a gas-cooled heterogeneous reactor, that requires fuel changing and control-rod servicing during operation is patented. The reactor has horizontal fuel and control-rod channels. Fuel handling is carried out at one face of the reactor, and control-rod extraction is carried out at another. A servicing machine is designed to be moved from one face to another and to be used for both control-rod extraction and fuel handling. The reactor and its pressure vessel, biological shielding, and steam-raising apparatus are all enclosed within a gas-containing structure. The 2 faces of the reactor to be serviced are outside of the gas-containing structure. (M.P.G.)

Production Reactors

38562 THE TWO-ZONE REACTOR. Erich Bagge (Institut für Reine und Angewandte Kernphysik, Kiel). Atomkernenergie, 8: 241-3(July-Aug. 1963). (In German)

The behavior of a thermal natural-uranium reactor with a high conversion ratio was studied. The principles of operation of a 2-Zone-Reactor is such that a central zone exists with a multiplication factor $k_\infty > 1$ and a conversion factor $C_\infty < 1$. This zone may be surrounded by a second zone in the form of a shell in which $k_\infty < 1$ and on the other side $C_\infty > 1$. The second zone is surrounded by a reflector. In this way the central zone operates as a neutron-producer for the 2nd shell, which completely absorbs these neutrons by U^{238} atoms and converts them into plutonium. Within the limits of the possibilities fixed by the number of fission neutrons η it is possible to vary the conversion ratios of the whole reactor by altering the dimensions and the volume ratio (fuel/moderator) of the different zones. It was found that conversion ratios above $C > 0.90$ are within the range of feasibility. (auth)

38563 STUDIES OF A 100-MW TWO-ZONE REACTOR. E. Bagge, H. Engel, and G. Locke (Christian-Albrechts-Universität, Kiel). Atomkernenergie, 8: 244-56(July-Aug. 1963). (In German)

A 100 MW natural-uranium reactor with D_2O as moderator in the neutron producing zone and with graphite in the conversion zones is described. The following topics are discussed: principle of a 2-zone reactor, plutonium production, structure materials and coolants, arguments for the choice of the proposed reactor, selection of the modera-

tors, geometrical arrangement of the zones, fuel elements, choice of the moderator to uranium ratio, selected conditions, cooling of the reactor with organic fluid, terphenyl as cooling-medium, thermal load of the components of the reactor, cooling of the moderator in the D_2O-zone, cooling of the moderator in the graphite-zone and in the reflector, reloading of fuel elements, neutron flux measuring and neutron flux control, description of the coolant circuits, reactor design, long-time behavior of the 2-zone reactor, total reactivity of the 2-zone reactor as a function of the burn-up, production of plutonium, and improvements of the technical conception of the 2-zone reactor. (auth)

Research Reactors

Refer also to abstracts 38007 and 38432.

38564 (AECL-1814) LATTICE PARAMETER MEASUREMENTS IN ZED-2. R. E. Green and C. B. Bigham (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 1963. 38p. (CONF-133-3)

From International Atomic Energy Agency Symposium of Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963.

Experiments were performed in the ZED-2 reactor to determine lattice parameters for fuel assemblies which closely resemble the fuel channels of the CANDU power reactor. The experimental fuel consisted of 19-rod clusters of 1.421 cm diameter, Zircaloy-clad UO_2 of density 10.45 gm/cm^3 housed in double-walled tube assemblies to simulate the pressure and calandria tubes of the power reactor. Measurements were made in hexagonal lattices for several pitches in the range 18 to 36 cm with three different materials filling the coolant spaces of the fuel assemblies; viz., D_2O, air (i.e. void) and an organic liquid called HB-40, which has the chemical formula $C_{18}H_{22.0}$. The moderator was in all cases D_2O. The following quantities were determined: bucklings that were derived from macroscopic flux distributions and reactivity measurements, microscopic neutron activation distributions from which the average neutron densities in the various cell materials were deduced, the epithermal neutron spectrum index, the effective neutron temperature, fast fission ratios, and initial conversion ratios. (auth)

38565 (BLG-188) CALCUL DES DISTRIBUTIONS DE TEMPERATURE DANS LES PLAQUES COMBUSTIBLES DE BR2 AVEC DECOLLEMENT DU GAINAGE OU INCLUSION D'URANIUM PUR. (Calculation of Temperature Distributions in BR2 Fuel Plate with Clad Bonding Defects or Inclusions of Pure Uranium). R. de Meersman and G. Minsart (Brussels. Centre d'Étude de l'Énergie Nucléaire). Dec. 1962. 39p.

The equations of the heat diffusion are solved with the help of a neutron diffusion code. This method is used for the study of two kinds of defects in the fuel plates of the BR2 reactor: clad bonding defect and uranium inclusion. The corresponding hot-spot factors are computed. Defects of circular and rectangular section are studied. (auth)

38566 (IDO-16885) FUEL PLATE EXPERIENCE DURING THE SPERT I DESTRUCTIVE TEST SERIES WITH AN ALUMINUM-CLAD, PLATE-TYPE CORE. J. Dugone and D. D. Wieland (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 24, 1963. Contract AT(10-1)-205. 97p.

A description is given of the fuel plate damage which occurred during the Spert I Destructive Test Program performed in 1962, using an aluminum-clad, plate-type fuel. Deformation of fuel plates was observed for power excursions having initial asymptotic reactor periods shorter than 9 msec and melting of plates was observed for tests with periods less than 5 msec. Damage due to pressure pulses was not observed on longer-period tests but was observed during the 3.2-msec-period test in which 35% of the core was melted and violent disassembly of the core occurred. Included are the results of metallurgical examinations of fuel samples and information on the extent of damage and melting experienced. The fuel plate damage that occurred during these tests is compared with fuel plate damage experienced in other reactors as a consequence of both planned and unplanned excursions. (auth)

38567 (IDO-16891) SELF-LIMITING EXCURSION TESTS OF A HIGHLY ENRICHED PLATE-TYPE D_2O-MODERATED REACTOR. PART I. INITIAL TEST SERIES. J. E. Grund (Phillips Petroleum Co. Atomic Energy Div., Idaho Fall, Idaho). July 12, 1963. Contract AT(10-1)-205. 89p.

Self-limiting power excursion tests were made to investigate the dynamic response of the Spert II BD-22/24 expanded D_2O core. This D_2O-moderated core is comprised of 3-in.-square × 24-in.-long, highly enriched, uranium–aluminum, plate-type fuel assemblies spaced on 6-in. centers. The power excursions were initiated by stepwise reactivity insertions with the system at ambient temperature and atmospheric pressure, with no forced coolant flow, and with approximately a 50-in. D_2O head over the core. The reactivity insertions ranged from about 40 cents to 3 dollars and resulted in initial asymptotic reactor periods of from about 10 sec to 50 msec. The basic self-shutdown mechanisms are apparently thermal in nature. For initial periods longer than 600 msec, the self-shutdown is due to nonboiling processes. For initial periods less than 600 msec, steam formation contributes to the self-shutdown and is apparently the predominant shutdown mechanism for power excursions with periods less than 100 msec. Limited mechanical damage to fuel plates is not obtained in tests with periods greater than 70 msec. Extrapolation of the fuel-plate surface-temperature data indicates that partial melting of the fuel plates might occur in tests with periods of 30 msec or less. The high fuel plate surface temperature required for melting is obtained as a result of the reduced heat transfer associated with partial film boiling and not as a result of excessive energy release. (auth)

38568 (IDO-24042) SUMMARY REPORT OF DESIGN CRITERIA FOR A THERMAL FLUX LIQUID METAL PACKAGE LOOP IN THE ADVANCED TEST REACTOR. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. and Ebasco Services, Inc., New York). Mar. 1963. Contract AT(10-1)-1075. 192p.

Results of the design criteria work performed prior to the termination of work on the package concept for the liquid metal loop facilities for the Advanced Test Reactor are summarized. Based on the results of the criteria studies, it was concluded that achievement of the design objectives could not be predicted with any high degree of confidence when utilizing the package loop concept based on the design philosophy of the PW-19 loop. The characteristics of the loop are given along with design and development accomplishments for associated equipment. (N.W.R.)

38569 (PAEC(D)PH-637) THE PRR-I NUCLEAR FUEL ELEMENTS. Jose O. Juliano and Roger R. Posadas

(Philippines. Atomic Energy Commission, Manila). June 1963. 22p.

A description is given of the fabrication of the U–Al alloys for the PRR-I fuel elements. The compositions of the U–Al melts and of the finished 32 fuel elements are tabulated in detail. The fuel inventory for the first loading of PRR-I is also listed. (D.L.C.)

38570 (UJV-943/63) ABSOLUTNÍ TOKY RYCHLÝCH NEUTRONŮ A JEJICH SPEKTRUM VE VERTIKÁLNÍCH KANÁLECH AKTIVNÍ ZÓNY REAKTORU VVR–S. (Absolute Fast Neutron Flux Spectra in Vertical Channels of WWR-S Reactor Core). Lubomir David (Československá Akademie Věd. Ustav Jaderného Výzkumu, Rez). 1963. 19p.

The results of measurements of the spatial and spectral distributions of absolute fast neutron fluxes in all the vertical irradiation channels in the WWR-S reactor core are described. (auth)

38571 GAMMA AND NEUTRON DOSIMETRY IN THE ASTRA REACTOR. A. Burtscher and G. Petschnik (Osterreichische Studiengesellschaft für Atomenergie GmbH. Vienna). Atompraxis, 9: 270-4(July 1963). (In German)

A calorimetric method is described for measuring dose output in the irradiation channels in the core of the ASTRA reactor. Dose outputs of gamma rays and fast neutrons were determined as a function of the H content of the sample, using sample bodies of C, Al, CH, and CH_2. The advantages and disadvantages of the method are discussed with reference to the results obtained. The accuracy of the method is about ±12%. (auth)

38572 FISSION PLATE POWER MEASUREMENT BY A TRANSIENT-TEMPERATURE METHOD. James N. Anno (Battelle Memorial Inst., Columbus, Ohio). Nucl. Sci. Eng., 16: 357-62(Aug. 1963).

Transient-temperature behavior following a step change in internal heat generation was analyzed to determine the power generation in the Battelle Shielding Facility fission plate. The fission plate is employed for shielding studies as a radiation source with a fission energy distribution. The plate is a 28-in diam, 0.0199-in. thick uranium disk containing 3741 gm of uranium enrichment to 93.14% in the uranium-235 isotope. It is plated with 0.0007 in. of nickel and clad with 0.025 in. of aluminum on each side and is in intimate contact with a 0.25-in. thick aluminum plate on one side. Ceramic spacers provide airgap insulation of the fission-aluminum plate combination from the surrounding media. Resistance thermometers were employed to observe the transient-temperature behavior following a step change in the internal heat generation in the plate for fission heating and for cooling tests. The cooling curve data were strictly exponential and rendered a decay constant of 0.0517 min^{-1} which was utilized, along with the physical constants of the assembly, to render a solution to the transient-heating equation and an estimated power of 25.0 ± 0.6 watts. (auth)

SPACE APPLICATIONS AND TECHNOLOGY

38573 (63SD760) RESEARCH ON SPACECRAFT AND POWERPLANT INTEGRATION PROBLEMS. First Quarterly Report, April 26 to July 26, 1963. (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Contract NAS 3-2533. 125p.

Mission requirements for unmanned scientific probes are outlined and spacecraft configuration and powerplant design studies for Rankine cycle turboelectric and in-core thermionic energy conversion systems are discussed. An examination of the existing booster vehicle programs leads to the selection of SATURN 1B and V for launching nuclear spacecraft. By further analysis a NAVIGATOR envelope of 17 planetary, asteroid, and solar missions was selected which are considered to be representative of the post-Voyager period in deep space exploration. The major categories of payloads were determined and weights, power consumption, heat rejection and general dimensions compiled. Capsule gross weights were estimated for combinations of atmospheric and propulsion braking to enter many planetary and satellite bodies of interest. Included in the estimates of spacecraft payloads were the results of radar and communication system studies which were explored in some detail. Communication system studies included antenna size and bandwidth selection, which also yielded estimates of weights, power consumption and dimensions. The cooling requirements for each type of spacecraft payload were then determined. Characteristic velocities were estimated for high and low thrust missions to permit comparison of nuclear electric systems with chemical or nuclear rockets. Geocentric, heliocentric, and planetary capture trajectories were computed for optimized low thrust missions with the objective of determining the effects of propulsion parameters. Data were obtained on mass ratio, thrust profile, power loading, specific impulse, launch dates, and travel time for various solar system missions. On the basis of radiator panel weight and structural design studies, the cone-cylindrical radiator configuration was selected. An examination of SATURN booster payload limiting characteristics yielded the spacecraft envelope restrictions on shape, C.G., and center of pressure. Estimates were made of payloads for boost to orbit, escape, and beyond escape. Power levels were set at 400 kw, 1 Mw and 5.25 Mw for turboelectric systems; and 275 kw, 1.13 Mw and 3.25 Mw for in-core thermionics. These ratings correspond to spacecraft weights of 28,000; 54,000; 90,000; and 240,000 pounds for different combinations of SATURN 1B and V launch vehicles. Preliminary selections were made on powerplant cycle conditions and working fluids. The non-condensing radiator concept was chosen to simplify the powerplant vehicle interface permitting the use of redundant radiators in large systems. On these bases, six spacecraft configuration layouts are to be prepared and of these, the 400 kw and 1Mw turboelectric systems have been completed. Fixed conical radiators are to be used for all but the 1 Mw and 5.25 Mw torboelectric systems where area is prohibitive for packaging on the booster. In those cases a deployable split-cone design is used so that the number of joints can be minimized and the radiator structural integrity preserved. The powerplant studies have progressed to the completion of an initial layout for a 1 Mw turboelectric system. For the thermionic powerplant, a two-loop system with high temperature (around 1800°F) radiators was selected. (auth)

38574 (LA-2909) A MONTE CARLO CALCULATION OF NEUTRON HEATING IN A NUCLEAR ROCKET PROPELLANT TANK. J. R. Streetman and G. A. Graves (Los Alamos Scientific Lab., N. Mex.). Apr. 30, 1963. Contract W-7405-eng-36. 79p.

Neutron energy deposition, neutron migration, and neutron absorption within liquid hydrogen contained in the propellant tank of a nuclear rocket was calculated for a 1000 Mw reactor. The heating values found are compared, both in magnitude and in variation with propellant depth, to those expected from the scattering of gamma rays produced from neutron captures in liquid hydrogen and to those expected from the scattering of gamma rays coming from the reactor itself. (auth)

38575 (NAA-SR-8303) AEROSPACE SAFETY REENTRY ANALYTICAL AND EXPERIMENTAL PROGRAM, SNAP 2 AND 10A (INTERIM REPORT). R. D. Elliott (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 30, 1963. Contract AT(11-1)-Gen-8. 69p.

Before a reactor is launched into a satellite orbit about the Earth, the hazards to the population must necessarily be considered in the event that the reactor re-enters the Earth's atmosphere and possibly impacts with the ground. Analytical and experimental efforts for calculating these potential hazards as they apply to SNAP-2 and -10A are described. (auth)

38576 (NASA-TR-R-174) THEORETICAL PERFORMANCE OF ELECTROSTATIC THRUSTORS WITH ANALYTIC SPACE-CHARGE FLOWS. William R. Mickelsen (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). 1963. 204p.

Theoretical performance parameters are derived for electrostatic thrustors with ion accelerators that have analytic space-charge-flow geometries. The performance parameters are exact, are in closed form, are directly related to mission-analysis and to powerplant-design parameters, and apply to both contact-ionization and electron-bombardment thrustors. The space-charge-flow geometries analyzed are unshielded plane diode, shielded plane diode with rectangular or circular ion beams, divergent or convergent flow between coaxial cylinders or concentric spheres, and circular flow. The analyses indicate that the divergent-cylindrical, divergent-spherical, and circular-flow geometries have the most promise for high-performance contact-ionization thrustors. (auth)

38577 (R62SD83) THERMODYNAMIC CONSIDERATIONS FOR MHD SPACE POWER SYSTEMS. Steven I. Freedman (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Sept. 1962. Contract Nonr-3867(00). 90p. (AD-291783)

Thermodynamic efficiencies and radiator sizes of Brayton Cycle MHD generator systems, with and without regenerators, were obtained. A new gas cycle, the Tri-Cycle, was synthesized. The Tri-Cycle has a radiator size as small as the regenerative Brayton Cycle, but a higher pressure ratio. A new cycle was discovered which

operates on a dissociating chemical reaction and combines the advantages of a dry gas expansion, a liquid compression, and a Rankine Cycle size radiator. Entropy generation in supersonic MHD generators was analyzed, the polytropic efficiency was related to the generator operating parameters. Transient boil-off and refrigeration techniques were examined. Multiple radiation shield insulation thicknesses were computed. An optimum temperature ratio for heat rejection from an active refrigeration system was found for superconducting magnets. (auth)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 37055 and 37292.

38578 (HW-78188) RESEARCH AND DEVELOPMENT ACTIVITIES [ON] FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, April–June 1963. E. R. Irish, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1963. Contract AT (45-1)-1350. 43p.

The radiant-heat spray calciner and pot calciner in the High-Level Radiochemistry Facility were used for additional experimental studies of full-level Purex 1 WW calcination. A spray calcination run was made with ammonia-neutralized waste for comparison with caustic-neutralized waste. Pot calcination runs were directed toward determining the effect of calcium on sulfate retention and fission product behavior and the effect of excess sodium nitrate on cesium loss and calcine stability. The large Cold Semiworks radiant-heat spray calciner was operated for further evaluation of the calciner capacity and filter system suitability. In addition, powders were produced for use in a corrosion study for the evaluation of calciner construction materials. Several scouting runs were made to evaluate the ability of the system for making phosphate glass. The parametric study of the electrostatic bubble scrubber was concluded. The status and schedule for the Waste Solidification Engineering Prototypes are discussed. A sugar denitration process for Purex 1 WW, as a substitute for the formaldehyde process, was developed through laboratory, hot-cell, and engineering-scale pilot plant studies and adopted for process testing in the plant. The zeolite Linde 13X was found to be cerium selective in the presence of alkali metal cations but not in the presence of alkaline earth cations. The kinetics of a replacement type reaction were examined experimentally and compared to a theoretical model developed by Crank. Binary ion exchange data were used to predict equilibrium distribution of cations between zeolites and solutions containing three or more exchangeable cations. Predicted values compared favorably with experimentally determined values. Ion exchange and sorption methods are being evaluated for removal of ruthenium from Purex acid recovery condensate. Experiments were continued in the Micro Pilot Plant with Purex Tank Farm condensate to evaluate the ability of thin precoat beds of an anion exchange resin for ruthenium decontamination. Additional data were obtained for definition of the flowsheet for cesium recovery from Redox high-level waste by use of Duolite C-3 resin. (auth)

38579 (ORNL-3277) ENGINEERING STUDIES ON POT CALCINATION FOR ULTIMATE DISPOSAL OF NUCLEAR WASTE FROM THE TBP-25, DAREX, AND PUREX PROCESSES. PART I. THE SYSTEM EVALUATION. C. W. Hancher, J. C. Suddath, and M. E. Whatley (Oak Ridge National Lab., Tenn.). Sept. 23, 1963. Contract W-7405-eng-26. 64p.

Experience with the operation of an experimental engineering-development pot-calcination facility, including two types of evaporators with associated control systems and a calciner pot up to 8 in. in diameter and 90 in. high, formed the basis for the recommendation of equipment and operating procedures for the hot-pilot-plant phase of the waste-calcination program. The performance of each component in the system is discussed. The evolutionary justification is given for choices of equipment and operational techniques which are recommended. The pot calcination process reduces radioactive liquid waste solutions to calcined solids, which are permanently stored in the calcination pot. It can handle wastes of a variety of fuel processes. Rehandling and packaging of the calcined solids are not required since the pot used for the final evaporation and calcination serves as the permanent storage vessel. The prolonged high temperature in the pot decreases nitrate in the solids to less than 500 ppm under ordinary conditions, leading to greater stability during storage. Ingredients for improving the physical or thermal properties of the solids or for fixation of isotopes can be incorporated in the system if desired. Performance information is presented for equipment and system behavior based on engineering scale studies of simulated waste from Purex, Darex, and TBP-25 plants. Two flowsheets (batch evaporation and continuous) were demonstrated satisfactorily after trial and error modification of the equipment and control systems. Average rates of 5 gal/hr were processed in the evaporator-calciner complex for all three types of waste (based on 40 gal/ton, Purex waste; 45 g Al/liter, TBP-25 waste; and 38 g Fe/liter, Darex waste). (auth)

38580 (ORNL-TM-600) THE PROGRAMMING OF POT CALCINER WALL TEMPERATURE TO ENSURE CALCINATION AT 1650°F UNDER OPTIMUM ECONOMIC CONDITIONS. S. H. Jury (Oak Ridge National Lab., Tenn.). Aug. 12, 1963. Contract [W-7405-eng-26]. 58p.

In the deposition and calcination of solid radioactive waste cake either radioactive volatiles escape from the cake or the cake is not properly calcined if the calcination temperature is not properly controlled. It is proposed along with the development of the theory that the calciner wall temperature should gradually be increased during startup from ambient to the calcination temperature and subsequently held there until in the solid cake that has built up on the cylindrical wall of the calciner there develops a temperature distribution such that a maximum sets in at the wall. At this time a gradual decrease in wall temperature should be programed such that the maximum proceeds inward toward the inner face of the cake. The maximum must always remain at the calcination temperature. After the feed is cut off wall temperature programing continues until the inner face of the cake comes up to the calcination temperature. After this time the vessel and the cake are ready for storage. The theory was applied through the medium of the IBM 7090 computer to calculate numerous wall temperature programs and cost optimizations for numerous illustrative cases. It was concluded that wall temperature programing is not only feasible but that it is an absolute necessity. An analysis of yearly plant calcination costs shows continuous decrease in cost as the vessel diameter increases and the fraction filled decreases accordingly. It is not practical to fill a vessel full because the entrainment velocity is exceeded and this with the velocity erosion effects on the cake become intolerable. It is necessary to apply the theory to a run before it is made in order to avoid wall temperatures at the end of the run which are either impractical or physically impossible. The rate of cooling of the calciner wall during the later stages of wall temperature programing is determined by the properties of the cake, the size of the vessel, and the extent to which the vessel is

filled. These factors must also be known before a run is made in order that appropriate provisions can be made for heat removal later in a run. Prior to shipment to storage the core of the calciner cake should be filled with earth, sand, etc. to avoid excessive temperatures that might be generated if the cylindrical cake broke during transit and fell to the bottom of the pot. (auth)

38581 SEPARATION OF Cs^{137} FROM HIGH-ACTIVITY RADIOACTIVE WASTE. Bedrijf en Tech., 18: 31(Jan. 1963). (In Dutch)

A process was developed on a laboratory scale to separate Cs^{137} from waste fuels of atomic reactors. The recovery of this powerful and industrially important γ emitter of 30 years half life is said to be so simple as to make it possible on an industrial scale. It is based on the preferential absorption of Cs by ammonium phosphor-molybdate from the nitric acid solution of the waste material and the subsequent extraction of Cs from its absorber. This method is more practical than other processes which are based upon precipitation and recrystallization of cesium salts. It was successfully tested on waste solutions of very different compositions. (OID)

38582 THE REMOVAL OF STRONTIUM^{90} FROM ORGANIC WASTE. M. Goldman, R. P. Anderson, E. Edgerley, Jr., and A. D. Ray (Univ. of California, Davis). Health Phys., 9: 847-55(Aug. 1963).

Continuous production of organic wastes from a large dog colony on a diet containing various amounts of Sr^{90} required the design and construction of a moderate-size waste treatment plant. The contaminated wastes contain in excess of 5×10^{-5} μc Sr^{90}/ml and are produced at approximately 200-500 gal/day. Decontamination depends upon efficient utilization of the principles of primary sedimentation, aeration, chemical clarification and filtration prior to passage of the waste through 5 ft^3 of cation exchange resin. The expended resins are disposed of by offsite burial. Treatment of over 115,000 gal of waste has produced final effluents whose average annual concentration does not exceed the current permissible limit for Sr^{90} in drinking water. The treated waste stream is discharged into an underground leaching field. Decontamination factors up to 5×10^4 have been achieved. The current cost of treatment is estimated at less than 15 cents/gal including material, (resin costs 1.2 cents/gal), labor and plant amortization. (auth)

CORPORATE AUTHOR INDEX

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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

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414	17-38494	For translation see AEC-tr-6010
CERN–	**(European Organization for Nuclear Research)**	
63-19	17-38312	Dep.(mc)
63-27	17-37930	Dep.(mc)
CONF-1–	**(Institute of Electrical and Electronics Engineers**	

Report No.	Abstract No.	Availability
	1963 Summer Meeting, Toronto, June 1963)	
24	17-37636	ORINS. Gmelin, AED-CONF-073-26, New York, Institute of Electrical and Electronic Engineers, 1963, Preprint Paper CP63-1182
CONF-9–	(Canadian Nuclear Association, International Conference and Future Development of Power Reactors and on Radioisotopes, Montreal, May 1963)	
26	17-37040	ORINS
CONF-10–	(American Institute of Aeronautics and Astronautics Electrical Propulsion Conference, Colorado Springs, Mar. 1963)	
34	17-37320	ORINS. New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63006
52	17-37321	ORINS. New York, American Institute of Aeronautics and Astronautics, 1963, Preprint 63044
CONF-23–	(American Physical Society, 1963 March Meeting, St. Louis, Mar. 1963)	
11	17-37737	J. Appl. Phys., 34: 2366-70(1963)
CONF-28–	(Second International Congress on Metallic Corrosion, New York, New York, Mar. 1963)	
6	17-37478	See EUR-379.e
CONF-39–	(American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963)	
94	17-37574	See WAPD-T-1570
CONF-47–	(Conference Deutsches Atomforum Atomstrahlung in Medizin Und Technik, Munich, Jan. 1963)	
1	17-37041	ORINS. Gmelin, AED-CONF-1963-006-2
CONF-73–	(Sixth Biennial Conference on Carbon, Pittsburgh, June 1963)	
12	17-37639	ORINS. Gmelin, AED-CONF-63-061-18
14	17-37568	See GA-4224
CONF-97–	(American Institute of Aeronautics and Astronautics Conference, Los Angeles, June 1963)	
14	17-37638	ORINS. New York, American Inst. of Aeronautics and Astronautics, 1963, Preprint 63-186, $1.00
18	17-37322	ORINS. New York, American Inst. of Aeronautics and Astronautics, 1963, Preprint 63-217, $1.00
23	17-37344	ORINS. New York, American Inst. of Aeronautics and Astronautics, 1963, Preprint 63-218, $1.00
CONF-102–	(American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963)	
5	17-38434	See HW-SA-3021
CONF-129–	(Heat Transfer Conference, Boston, Aug. 1963)	
13	17-37330	See BNL-6672
CONF-132–	(Fourth International Symposium on Space Technology and Science, Tokyo, Aug. 1962)	
1	17-37323	ORINS
CONF-133–	(International Atomic Energy Agency Symposium of Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963)	
2	17-38493	See WAPD-T-1594
3	17-38564	See AECL-1814

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CONF-148–	(Symposium on Nuclear Ship Propulsion, Turin, Oct. 1962)	
1	17-38560	ORINS
CONF-168–	(21st Annual Meeting of the Electron Microscope Society of America, Denver, Aug. 1963)	
1	17-37361	ORINS
CONF-174–	(12th Annual Conference on Application of X-ray Analysis, Denver, Aug. 1963)	
1	17-37499	ORINS. Gmelin, AED-CONF-63-123-3
CONF-175–	(American Chemical Society 142nd National Meeting, Atlantic City, Sept. 1962)	
1	17-37637	ORINS. Gmelin, AED-CONF-63-125-1
CONF-181–	(Utilization of Multiparameter Analyzer Meeting, Grossingers, N. Y., Nov. 1962)	
3	17-37398	See TID-17848
CONF-191–	(Society of Automotive Engineering Symposium, Los Angeles, Sept. 1963)	
1	17-37401	See UCRL-7361
CONF-193–	(8th Nuclear Congress, Rome, June 1963)	
2	17-38541	See DPR/INF/272
CONF-197–	(Symposium on Scientific Problems of Shelter Construction, Zurich, July-Aug. 1963)	
1	17-37351	See SCR-679
CONF-198–	(United States Public Health Service Training School on Meteorological Aspects of Air Pollution, Berkeley, Calif., Aug. 14, 1963)	
1	17-37364	See HW-SA-3144
CONF-202–	(The Electrochemical Society Fall Meeting, New York, Sept. 1963)	
1	17-37481	See HW-SA-2954
CONF-203–	(Colloquium on the Optics of Solid Thin Films, Marseille, Sept. 1963)	
1	17-37647	See LADC-5695
CONF-204–	(International Conference on Lattice Dynamics, Copenhagen, Denmark, Aug. 1963)	
2	17-37648	See LADC-5748
CONF-205–	(International Atomic Energy Agency Symposium on the Biological Effects of Neutron Irradiation, Upton, N. Y., Oct. 1963)	
1	17-37138	See LADC-5747
CONF-206–	(Symposium on Carbides in Nuclear Energy, Harwell, Eng., Nov. 1963)	
1	17-37170	See ORNL-TM-668
COO–		
267	17-38460	See TID-7674
CYNA–	(Misc.)	
191	17-38539	Dep.(mc); $3.60(fs), $1.25(mf) OTS
DCAS-TDR–	(Non-AEC)	
62-171	17-37645	$3.60(OTS)
DP–		
855	17-38540	Dep.; $1.00(OTS)
DPR-INF–	(British)	
272	17-38541	Dep.(mc)
CU(PNPL)–		

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227(p.59-69)	17-37398	See TID-17848
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EFINS–	**(Misc.)**	
63-28	17-37957	Phys. Rev., 132: 434-41(1963)
EIR–	**(Swiss)**	
53	17-38415	Dep.(mc)
EUR–	**(European Atomic Energy Community)**	
295.f	17-37248	Dep.(mc)
330.i	17-38542	Dep.(mc)
377.d	17-37331	Dep.(mc)
379.e	17-37478	Dep.(mc)
406.e	17-37394	Dep.(mc)
EURAEC–		
133	17-38430	Dep.(mc); $1.10(fs), $0.80(mf) OTS
188	17-38495	Dep.(mc); $3.60(fs), $1.40(mf) OTS
274	17-37565	Dep.(mc); $1.60(fs), $0.80(mf) OTS
355	17-37456	See GEAP-3902
357	17-37457	See GEAP-3916
665	17-37295	Dep.(mc); $4.60(fs), $1.43(mf) OTS
670	17-37176	Dep.(mc); $5.60(fs), $1.91(mf) OTS
FFIK-IR–	**(Norwegian)**	
K-251	17-37053	Dep.(mc)
K-253	17-37054	Dep.(mc)
FTD-TT–	**(Non-AEC)**	
63-174	17-37466	OTS
63-424	17-37575	$1.10(OTS)
63-514	17-38368	OTS
63-664	17-37056	OTS
FZK–	**(Non-AEC)**	
142	17-37566	
161-2(Vol.II)	17-37567	
GA–	**(Misc.)**	
2372	17-38431	Dep.; $2.50(OTS)
4224	17-37568	Dep.(mc); $2.60(fs), $0.95(mf) OTS
4287	17-37569	Dep.(mc); $2.60(fs), $1.01(mf) OTS
4426	17-37993	Dep.(mc); $4.60(fs), $1.64(mf) OTS
4484	17-37570	Dep.(mc); $1.10(fs), $0.80(mf) OTS
4488*	17-38432	Dep.(mc); $2.60(fs), $1.07(mf) OTS
4495	17-37508	Dep.(mc); $2.60(fs), $0.83(mf) OTS
GAMD–	**(Misc.)**	
1776	17-38433	Dep.(mc); $2.60(fs), $0.83(mf) OTS
GEAP–	**(Misc.)**	
3902	17-37456	Dep.(mc); $1.10(fs), $0.80(mf) OTS
3916	17-37457	Dep.(mc); $1.10(fs), $0.80(mf) OTS
4181	17-37479	Dep.; $2.75(OTS)
4226	17-38543	Dep.; $1.00(OTS)
GEMP–		
219	17-37489	Dep.(mc); $5.60(fs), $1.73(mf) OTS
239	17-38544	Dep.(mc); $15.00(fs), $6.98(mf) OTS
HMI-B–	**(German)**	
26	17-37002	Dep.(mc)
HW–		
73913	17-37154	Dep.(mc); $3.60(fs), $1.40(mf) OTS
76358	17-37480	Dep.; $0.75(OTS)
76642	17-37571	Dep.; $0.50(OTS)
77594	17-37332	Dep.; $1.00(OTS)
78118	17-37003	Dep.; $2.75(OTS)
78132	17-37509	Dep.; $0.50(OTS)
78178	17-37572	Dep.; $0.50(OTS)
78188	17-38578	Dep.; $1.00(OTS)
78274	17-38416	Dep.; $0.75(OTS)
HW-SA–		
2893	17-37204	J. Phys. Chem., 1568-9(1963)
2954	17-37481	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3021	17-38434	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3144	17-37364	Dep.(mc); $1.60(fs), $0.80(mf) OTS
IA–	**(Non-AEC)**	
761(App.)	17-37994	Dep.(mc)
IDO–		
16885	17-38566	Dep.; $2.00(OTS)
16891	17-38567	Dep.; $2.00(OTS)
24042	17-38568	Dep.; $2.75(OTS)
24041	17-38435	Dep.; $3.00(OTS)
28612	17-38545	Dep.; $1.50(OTS)
IGR-TM–	**(British)**	
C-0164	17-37510	Dep.(mc)
IITRI–	**(Misc.)**	
1193-26	17-38063	Dep.(mc); $3.60(fs), $1.40(mf) OTS
1194-13	17-37004	Dep.; $1.75(OTS)
IS–		
624	17-37404	J. Appl. Phys., 34: 2486-7(1963)
474	17-37511	Dep.(mc); $3.60(fs), $1.16(mf) OTS
662	17-37458	Dep.; $0.50(OTS)
JAERI–	**(Japanese)**	
5009	17-37313	
6012	17-38417	
6013	17-38064	
JINR–	**(Russian)**	
P-1231	17-38065	Dep.(mc)
P-1273	17-38080	Dep.(mc)
P-1281	17-37449	Dep.(mc)
P-1282	17-37931	Dep.(mc)
P-1284	17-37932	Dep.(mc)
P-1286	17-38081	Dep.(mc)
P-1291	17-38082	Dep.(mc)
P-1297	17-37933	Dep.(mc)
P-1299	17-38083	Dep.(mc)
P-1303	17-38084	Dep.(mc)
P-1309	17-37934	Dep.(mc)
P-1312	17-37935	Dep.(mc)
P-1321	17-37936	Dep.(mc)
P-1332	17-37937	Dep.(mc)
P-1353	17-37938	Dep.(mc)
JPRS–	**(Non-AEC)**	
20795	17-37020	$0.50(OTS)
20872	17-37366	$0.50(OTS)
20948	17-37141	$0.50(OTS)
20960	17-37066	$0.50(OTS)
20964	17-37067	$0.50(OTS)
20988	17-37023	$0.50(OTS)
20997	17-37068	$0.50(OTS)
21086	17-37024	$0.50(OTS)
21109	17-37057	$2.00(OTS)
21170(Del.)	17-37069	OTS
21171(Del.)	17-37025	OTS
21171(Del.) (p.6-13)	17-37026	OTS
21171(Del.)	17-37027	OTS

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(p.14-23)		
21171(Del.)	17-37028	OTS
(p.24-31)		
KAPL-M–		
CC-4	17-37482	Dep.(mc); $1.60(fs), $0.80(mf) OTS
DTG-2	17-38085	Dep.(mc); $1.60(fs), $0.80(mf) OTS
EC-30	17-37333	Dep.(mc); $7.60(fs), $2.36(mf) OTS
EC-32	17-37995	Dep.(mc); $8.10(fs), $2.72(mf) OTS
FDF-3	17-38418	$27.25(fs), $10.78(mf) OTS
JJI-1	17-37512	Dep.(mc); $1.60(fs), $0.80(mf) OTS
KFK–	**(German)**	
146	17-38554	Arch. Tech. Messen, Lfg., 326: R25-30 (1963)
KN–	**(Non-AEC)**	
62-133(R)	17-37646	
KR–	**(Norwegian)**	
49	17-37005	Dep.(mc)
LA–		
2909	17-38574	Dep.; $2.00(OTS)
2910	17-37334	Dep.; $2.75(OTS)
LADC–		
5554	17-37042	Dep.(mc); $1.60(fs), $0.80(mf) OTS J. Appl. Physiol., 18: 786-8(1963)
5693	17-37209	J. Phys. Chem., 67: 1731-3(1963)
5695	17-37647	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5729	17-38111	J. Inorg. Nucl. Chem., 25: 1196-8(1963)
5747	17-37138	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5748	17-37648	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5801	17-38128	Phys. Rev., 132: 355-61(1963)
5804	17-37858	Phys. Rev., 132: 236-40(1963)
5813	17-37844	Phys. Rev., 132: 10-14(1963)
LRP–	**(Swiss)**	
1-63	17-38376	Dep.(mc)
2-63	17-37395	Dep.(mc)
5-63	17-38377	Dep.(mc)
MATT–		
178	17-38397	Phys. Fluids, 6: 1506-15(1963)
MIT-DSR–	**(Non-AEC)**	
8535	17-37649	$2.60(OTS)
MND-M–	**(Misc.)**	
2935(Vol.II)	17-38546	Dep.; $4.00(OTS)
NAA-SR–		
5200	17-37251	Dep.; $0.50(OTS)
8108	17-37490	Dep.; $0.50(OTS)
8263	17-37491	Dep.; $0.50(OTS)
8303	17-38575	Dep.; $1.75(OTS)
NAA-SR-Memo–		
8481	17-37459	Dep.(mc); $2.60(fs), $0.92(mf) OTS
NASA-TN–	**(Misc.)**	
D-1879*	17-37650	$1.00(OTS)
NASA-TR–	**(Non-AEC)**	
R-174	17-38576	
R-181	17-37894	
NMI–	**(Misc.)**	
2807	17-37460	Dep.; $2.75(OTS)
2810	17-37513	Dep.(mc); $4.60(fs), $1.61(mf) OTS

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NP–	**(AEC File No. for Non-AEC Reports)**	
13054	17-37514	Dep.(mc)
13078	17-37365	Dep.(mc)
13086	17-38086	
13088	17-38547	Dep.(mc); $16.50(fs), $7.97(mf) OTS
13095	17-37006	Dep.(mc)
13100	17-37314	OTS
13101	17-37651	OTS
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
1056	17-37940	Dep.(mc); $1.60(fs), $0.80(mf) JCL
1057	17-38379	Dep.(mc); $7.60(fs), $2.33(mf) JCL
1061	17-37403	Dep.(mc); $1.60(fs), $0.80(mf) JCL
NRC–	**(Canadian)**	
7464	17-37522	Can. J. Phys., 41: 1397-1404(1963)
7513	17-37425	Can. J. Phys., 41: 1489-1518(1963)
NSEC–		
98	17-37349	Dep.(mc); $5.60(fs), $1.94(mf) OTS
NYO–		
8627	17-37461	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9505	17-37007	Dep.(mc); $12.00(fs), $5.15(mf) OTS
10027	17-38436	Dep.(mc); $9.10(fs), $3.38(mf)
10034	17-38087	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10149	17-37315	Dep.(mc); $3.60(fs), $1.22(mf) OTS
10307	17-37261	See RRL-86
10589	17-37018	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10616	17-37063	Dep.(mc); $1.10(fs), $0.80(mf) OTS
10691(Pt.1)	17-37652	$9.60(fs), $3.68(mf) OTS
ORA–	**(Misc.)**	
04653-S-P	17-37336	See TID-19371
ORNL–		
3277	17-38579	Dep.; $1.50(OTS)
3409	17-37055	Dep.; $2.50(OTS)
3468	17-37653	Dep.; $6.60(fs), $2.21(mf) OTS
3483	17-38437	Dep.; $2.00(OTS)
3493	17-38088	Dep.; $1.75(OTS)
ORNL-RMIC–	**(Oak Ridge National Lab.)**	
1	17-37654	Dep.; Free (ORNL)
ORNL-TM–		
586	17-37292	Dep.(mc); $3.60(fs), $1.40(mf) OTS
600	17-38580	Dep.(mc); $5.60(fs), $1.94(mf) OTS
618	17-37335	Dep.(mc); $3.60(fs), $1.19(mf) OTS
647	17-37462	Dep.(mc); $2.60(fs), $0.86(mf) OTS
650	17-37658	Dep.(mc); $1.60(fs), $0.80(mf) OTS
668	17-37170	Dep.(mc); $1.60(fs), $0.80(mf) OTS
682	17-37293	Dep.(mc); $2.60(fs), $0.83(mf) OTS
OTS–	**(Misc.)**	
63-31614*	17-37020	See JPRS-20795
63-31658*	17-37366	For translation see JPRS-20872
63-31688*	17-37141	For translation see JPRS-20948
63-31697*	17-37066	For translation see JPRS-20960
63-31698*	17-37067	For translation see JPRS-20964
63-31709*	17-37023	For translation see JPRS-20988
63-31716*	17-37068	For translation see JPRS-20997
63-31762*	17-37024	See JPRS-21086
63-31775*	17-37057	See JPRS-21109
63-31802(Del.)*	17-37069	For translation see JPRS-21170(Del.)
63-31803(Del.)*	17-37025	For translation see JPRS-21171(Del.)
63-31803(Del.) (p.6-13)*	17-37026	For translation see JPRS-21171(Del.) (p.6-13)
63-31803(Del.) (p.14-23)*	17-37027	For translation see JPRS-21171(Del.) (p.14-23)
63-31803(Del.)	17-37028	For translation see JPRS-21171(Del.)

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PAEC(D)PH–	**(Philippines)**	
637	17-38569	Dep.(mc)
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
873,077	17-37324	
933,217	17-38515	
933,382	17-38516	
933,408	17-37473	
933,429	17-37892	
933,436	17-37291	
933,451	17-38517	
933,455	17-38518	
933,475	17-38519	
933,500	17-38520	
933,523	17-38521	
933,816	17-38522	
933,817	17-38523	
933,824	17-37500	
933,982	17-38524	
934,009	17-38525	
934,031	17-38526	
934,217	17-37391	
934,218	17-37392	
934,222	17-37325	
934,223	17-38527	
934,254	17-37501	
934,327	17-37326	
934,409	17-37345	
934,622	17-38528	
935,025	17-38529	
935,052	17-37393	
935,092	17-38530	
935,130	17-38531	
935,464	17-38532	
935,510	17-38533	
936,004	17-37474	
936,007	17-37475	
936,012	17-37327	
936,028	17-38561	
936,040	17-37476	
936,166	17-37502	
936,170	17-38534	
936,377	17-37418	
936,518	17-38535	
936,626	17-38536	
937,244	17-37328	
PUC–		
1963-102	17-38123	Phys. Rev., 132: 310-15(1963)
R–	**(Misc.)**	
2083	17-37565	See EURAEC-274
62SD83*	17-38577	$8.10(OTS)
RDR–	**(Non-AEC)**	
1322-2	17-37487	See AD-295919
REIC-Access–	**(Non-AEC)**	
63	17-37573	
RRC–		
0101	17-37660	See TID-19333
RRL–		
86	17-37261	J. Phys. Chem., 67: 1399-1401(1963)
118	17-37252	Dep.(mc); $1.60(fs), $0.80(mf) OTS
RSIC–	**(Non-AEC)**	
42	17-37666	OTS
43	17-37667	OTS
RT-EC–	**(Italian)**	
(62)5	17-38548	Dep.(mc)
RT-EL–	**(Italian)**	
(63)11	17-37396	Dep.(mc)
(63)12	17-37397	Dep.(mc)
RT-ING–	**(Italian)**	
(63)8	17-38549	Dep.(mc)
SB–	**(Non-AEC)**	
63-26	17-37651	See NP-13101
63-40	17-37314	See NP-13100
SC–	**(Misc.)**	
4693(RR)	17-37350	Dep.(mc); $7.60(fs), $2.48(mf) OTS
SCDC–		
3230	17-37920	See TID-18698
SCL-B–		
107	17-37492	Dep.(mc); $7.60(fs), $2.36(mf) OTS
SCR–		
679	17-37351	Dep.; $0.75(OTS)
SL–	**(Misc.)**	
2008	17-38550	Dep.(mc); $18.50(fs), $9.05(mf) OTS
SRO–		
93	17-38551	Dep.(mc); $1.10(fs), $0.80(mf) OTS
STI-PUB–	**(International Atomic Energy Agency)**	
t0(p.101-8)	17-37140	For translation see AEC-tr-5996
SWRI–		
5-1276-7-2	17-37515	Dep.(mc); $8.60(fs), $3.17(mf) OTS
5-1348-7-1	17-38552	Dep.(mc); $4.60(fs), $1.61(mf) OTS
TDR–	**(Non-AEC)**	
69(2220-40)TR-2	17-37645	See DCAS-TDR-62-171
TID–		
7653(Pt.I)	17-38438	Dep.; OTS
7674	17-38460	Dep.(mc); $9.10(fs), $3.41(mf) OTS
15886	17-37616	J. Phys. Soc. Japan, 18: Suppl. III, 288-92(1963)
15953	17-38178	p.56-7 of "Direct Interactions and Nuclear Reaction Mechanisms." New York, Gordon and Breach, Science Publishers, 1963.
16142(Pt.III)	17-38507	Nucl. Sci. Eng., 16: 369-80(1963)
16873	17-37579	J. Appl. Phys., 34: 827-30(1963)
16966	17-37316	Dep.(mc); $2.60(fs), $1.10(mf) OTS
17346	17-37917	$1.10(fs), $0.80(mf) OTS
17608	17-37317	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17624	17-37516	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17630	17-37419	Dep.(mc); $2.60(fs), $1.04(mf) OTS
17632	17-37019	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17643	17-38089	Dep.(mc); $1.60(fs), $0.80(mf) OTS Nucl. Phys., 46: 246-50(1963)
17646	17-37996	Dep.(mc); $4.60(fs), $1.58(mf) OTS
17647	17-37249	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17663	17-38090	Dep.(mc); $2.60(fs), $1.01(mf) OTS Nucl. Phys., 46: 129-40(1963)
17694	17-37919	J. Geophys. Res., 68: 5069-78(1963)
17704	17-37318	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17733	17-37171	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17848	17-37398	Dep.(mc); $2.60(fs), $0.89(mf) OTS

Report No.	Abstract No.	Availability
17993	17-37463	Dep.(mc); $1.60(fs), $0.80(mf) OTS Trans. AIME, 227: 1166-70(1963)
18172	17-37198	J. Phys. Chem., 67: 1506-9(1963)
18279	17-37742	J. Appl. Phys., 34: 2422-5(1963)
18369	17-37297	J. Inorg. Nucl. Chem., 25: 1175-89(1963)
18573	17-38144	Z. Physik, 175: 184-99(1963)
18657	17-37064	Dep.; $0.50(OTS)
18698	17-37920	J. Geophys. Res., 68: 5125-33(1963)
19115	17-38127	Phys. Rev., 132: 346-54(1963)
19325	17-37659	Dep.(mc); $6.60(fs), $2.09(mf) OTS
19333	17-37660	Dep.(mc); $8.10(fs), $2.78(mf) OTS
19350	17-38091	Dep.(mc); $10.10(fs), $3.98(mf) OTS
19351	17-37253	Dep.(mc); $3.60(fs), $1.22(mf) OTS
19367	17-37148	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19371	17-37336	Dep.(mc); $10.10(fs), $4.04(mf) OTS
19378	17-38492	Dep.(mc); $3.60(fs), $1.34(mf) OTS
19380	17-37399	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19381	17-37254	Dep.(mc); $6.60(fs), $2.30(mf) OTS
19382	17-37517	Dep.(mc); $2.60(fs), $1.07(mf) OTS
19383	17-37483	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19385	17-38092	Dep.(mc); $2.60(fs), $1.04(mf) OTS
19388	17-37139	Dep.(mc); $4.60(fs), $1.49(mf) OTS
19391	17-38514	Monograph Series on Nuclear Science and Technology. New York, Rowman and Littlefield, Inc., 1963. $6.95
19393	17-37400	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19394	17-37464	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19395	17-37484	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19397	17-37149	Dep.(mc); $2.60(fs), $0.86(mf) OTS
19407	17-37065	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19415	17-37661	Dep.(mc); $1.10(fs), $0.80(mf) OTS
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Ser-100	17-37495	Dep.; $1.60(fs), $0.80(mf) JCL
Ser-191	17-37521	Dep.; $1.10(fs), $0.80(mf) JCL or OTS
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6367	17-37616	See TID-15886
6594	17-37579	See TID-16873
6734	17-37430	See ANL-FGF-350
6946	17-37347	See ANL-FGF-394
6965	17-38090	See TID-17663
6976	17-37516	See TID-17624
6979	17-37019	See TID-17632
6984	17-37996	See TID-17646
6996	17-37419	See TID-17630
7009	17-38089	See TID-17643
7048	17-37398	See TID-17848
7146	17-37198	See TID-18172
7209	17-37297	See TID-18369
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6580	17-37783	J. Phys. Soc. Japan, 17: Suppl. B-I, 249-52(1962)
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7129	17-38093	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7136	17-37206	J. Phys. Chem., 67: 1586-9(1963)
7149	17-37663	Dep.(mc); $3.60(fs), $1.13(mf) OTS
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10750	17-38404	Rev. Geophys., 1: 283-304(1963)
10784	17-37414	Rev. Sci. Instr., 34: 1026-8(1963)
10844	17-37759	J. Chem. Phys., 39: 1128-9(1963)
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